DEDICATED

To the Honest People of the United States.

BUILDING

SAFE-GUIDE,

—BY—

CHARLES MARCOTTE,

ARCHITECT.

ST. LOUIS:
SLAWSON & PIERROT, PRINTERS,
1879

J. F.

INDORSED.

We, the undersigned, do hereby indorse the "BUILDING SAFE-GUIDE" of Charles Marcotte, Architect. In our opinion, the New System of Transacting the Building Business contained therein, is the only correct and reliable way for all parties concerned in such business and should be carried out into practice.

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I think this work a most valuable guide to owners contemplating building.

SILAS BENT.

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PREFACE.

THE main objects for publishing this work aim entirely at the protection of all Owners, Agents, Architects, Mechanics, and others who are concerned in the Building Business; also at the interests of all Tax-payers in this country.

The work is divided in three parts.

The objects of Part First are the following:

1. All classes of society, and every individual, should know that rumors prevail, proofs may be given, and it is a fact known by a large portion of the population (if not by all) that frauds and schemes of plunder are or may be perpetrated by men or rings, in all the mechanical branches connected with Buildings; that some architects and agents may receive from mechanics illegitimate commissions either in money or other emoluments; that some architects and mechanics, taking contracts for Buildings on their own plans and specifications, may also act most fraudulently.

The Building Business involves such large sums of money, that if the frauds and schemes of plunder which may be perpetrated in buildings, both public and private, are only equal to rumors and allegations, they must be enormous, and most detrimental to the prosperity of the people.

2. To show, according to the most reliable informations, the ways and means which are used, and all parts of the Building where the evil may be carried on, and to prove that such evil must be attributed to the defects of the present system of transacting business.

Part Second offers a system of transacting the Building Business, so true and reliable for the safety of all parties, as to defeat at the outset all schemes of plunder which may be intended by any men or rings as regards the construction of both public and private buildings.

Part Third treats briefly of building materials, and describes fully the different qualities of workmanship in all trades connected with Building, so as to enable any one to see that every contractor executes his work in strict accordance with the contract.

Moreover, it exposes in the most lucid manner, and explains in detail all the frauds which may be perpetrated in the work, while being executed; suggesting also all practical ways and means that can be used by the most inexperienced persons to detect such frauds and render their perpetration impossible, not only in new buildings, but also in alterations and repairs of old ones.

Notice.—This treatise, which is based on practice, is accompanied with the necessary Plates, and Tables showing the size and strength of sheet metals, lead and iron pipes, etc., as manufactured and generally used in buildings.

I have not spared any labor or expense in getting all proper informations concerning the secrets of the building trades.

All the statements and figures contained therein are warranted to be correct, as a great many mechanics and others are ready to rise and swear to them; therefore do I set at defiance all adversaries who may be disposed at any time to make serious objections to this work.

Truth and Justice cannot Offend or Affect any one but the "Guilty."

No honest man should be offended at the exposure of the frauds known to be so frequently perpetrated in the construction of buildings, or be opposed to the New System of transacting the Building Business, which is acknowledged by men of great experience as the only proper and possible way to keep pace with the dishonest exertions of men or rings, and defeat, in all cases, their intended schemes of plunder. But some persons who raise objections to the New System suggested, tell me: "Let the owners transact business in the old way, and employ men in whom they have confidence!" My answer to this is very plain; owners may rely on their architect and the mechanics for the construction of their buildings, and at the same time secure themselves in regard to the financial matters concerning such buildings, as when they transact any other business with other classes of society. Architects and mechanics who may have heretofore perpetrated frauds, had the full confidence of their patrons; for, had they not been trusted too far, they could never have been successful in their criminal schemes; and in many cases the more confident were the Public or owners, the more they may have been defrauded.

I am willing to admit that such abuses of trust may be practiced only by a few men in each branch of the building business, but such is the difficulty of our position that we cannot always tell who they are, even if we know them, and of course being unable to draw the "line" between the "just" and the "unjust" among men enjoying the same privileges of freedom, so does it become necessary for

every one, without exception, to follow the same rules, however strict they may be, in order to succeed in establishing universally a legitimate business.

There are some architects, mechanics, and old gray-haired men too, having an established reputation for a great many years, with a large custom, and known in their respective locality and abroad, as practitioners of perfect integrity, who, far from being humiliated by this way of doing business, are willing in all cases to give owners full assurance and proof that they cannot be deceived nor defrauded in the construction of their buildings.

Moreover, a great many owners have already adhered to this system of transacting business since the first publication of the BUILDING SAFE-GUIDE, and of course every one of them will be apt to adopt it.

When an architect is intrusted with the construction of a building, he should not expect to have an unbounded control of the financial matters concerning the work Honest architects have so much to do in attending to their own business that they can be well excused in leaving owners to take care of their own money affairs. All they ask is a fair compensation for their services.

Appearances justify suspicion, and when large sums of money are at stake, suspicion becomes a just ground of inquiry.

Criminal cases have been sometimes instituted against architects and mechanics, who were perhaps innocent; in these cases neglect or carelessness may have been the only cause of their misfortunes. Had they transacted their business according to this system, being thereby relieved from all suspicions, they would never have gone through such humiliating trials, to say the least, nor would they have incurred public censure or condemnation.

It is reported from various sources that some parties are strongly opposed to this work, and in their dissatisfaction, do not feel very friendly towards me for having divulged

"frauds" called by them the "secrets" of the Building Business. I am not at all surprised at this, as I expected it from the beginning. I may fairly say that, if every one be naturally disposed to approve of it, there would be no cause for this publication, and as a matter of course the idea would never have presented itself to my mind.

Let me ask our adversaries and the most severe censurers of my conduct, to rise at once before the Public and express loudly whether in their opinion the old system of transacting the Building Business justifies this publication, or whether it is so perfect that it cannot be improved; for, in the first case they would give a fair evidence that they have been unjust in their transactions of the past, and also feel defeated by this GUIDE, in some future schemes; and in the latter case they would be most erroneous, as a great many can testify to the frauds mentioned in this work, and no one denies them. Not only the individuals, but the Press also, through the whole country have acknowledged the frauds in a general way at least. Therefore do I claim that the enemies of this work are strongly opposed to the interests of society at large.

Again, some practitioners have asserted that the New System of transacting the Building Business would render the architects and the mechanics the "valets" of the owners; this assertion is false, and every reasonable man can see that it will not only be beneficial to the owners, but will also protect all honest and competent architects and mechanics against others who may be dishonest or devoid of all the necessary abilities. A man is not a valet when he acts so as to relieve himself from all dangerous suspicions. He is a free man who is always ready to prove his transactions to be just.

With all their mean dispositions, it is very natural for them to make such objections; but these attempts can only turn as arguments against such practitioners, who show more vanity and conceit than honor; as every one can see

that they may seek a subterfuge to act in darkness, as they did heretofore, and may thereby relieve themselves from the principal obligations and duties incumbent upon men.

Some of those who may have made such assertions, if they think deeply on the subject, should be very grateful to me for doing them the honor yet of being elevated from the rank of "hirelings or thieves," to the simple position of "valets," for they are well known among certain classes. A few of them, after having been bought, and become of course, the "valets" of those who had been placed under them were sold afterwards by men of their own ring, who have divulged their dishonest transactions.

When neither the feelings of shame, the sense of honor, the reproaches of conscience, nor the fear of punishment, can form any bar to the criminal designs of these practitioners in various localities of the country, it is evident they can only find their safety, and are allowed to breathe the air of liberty through the unbounded generosity of the people; for, had it depended on themselves and their own ring, they might have been implicated long ago.

Owners should not trust too hastily appearances or demonstrations of any kind, whatever they may be; for God alone knows the heart of every man, and men want proofs from men besides pretenses. It is well known that hypocrites are scattered on the face of the earth, that imposters with winning ways and a honey tongue are designing constantly under a mask. They have no character, but want to enjoy a good reputation; they always want to be trusted, but they are not worthy of trust in any transactions. In their opinion, honesty and folly or stupidity are synonymous terms; and being villains, they fancy themselves to be men of great abilities, because they excel in the art of deceiving others.

I can feel proud in saying that since the first publication of this work, I was not only honored by forfeiting the regard of our adversaries, but I had also the good will and

support of a great many men of position and character, to whom I am very much indebted for the success already attained in the course I am pursuing, and whose esteem and consideration I hope to possess, and shall endeavor to deserve until the last moment of my life.

Notice.—All architects, builders and mechanics having their names connected with this work are willing to agree and bind themselves to transact business with owners according to the system contained therein. Some others who have not signed this GUIDE have declared to be in favor of it.

CHARLES MARCOTTE, ARCHITECT,
Author.

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REMARK.—The Plates are connected with Stone and Brick Masonry.

PART FIRST.

Owners, Agents, Administrators, Architects, Builders, Mechanics.—Defects in the Present System of Transacting the Building Business.—How Frauds and Schemes of Plunder can be Perpetrated, with Ways and Means, According to Rumors and Allegations that Proofs can be Given in Many Cases.

1. Plans may be drawn out at first for a larger and more complicated building than that intended to be erected, and the specifications may be written for better work than that proposed to be executed, exaggerating also all details. The mechanics who bid on them without knowledge of any scheme, may be defeated in their estimates or bids, by favored mechanics forming a ring with the architect, and who have made their own bids according to some other plans and specifications drawn out with intent and purpose. These favorites may pay such architect a certain sum, for the contract of the work, over the commission which he is already getting from the owner for his professional services, and, of course, judging from the transaction, the owner pays both of the commissions, not knowing the fraud perpetrated on him; and moreover, he may pay the mechanics more than he would if the competition had been just and fair.

2. The mechanics forming a ring with the architect may all bid on the same plans and specifications, but some of them who get the contracts of the buildings, may be allowed by such architect to deviate from such plans

and specifications, and furnish inferior materials and do inferior work in all parts of such buildings. The architect may divide the spoils with the mechanics, and again the owner is deceived and defrauded.

3. In many cases the bids may be opened by some architects, who will sometimes change them, or raise the amount of the lowest bid, still keeping it a few dollars lower than the next one, in order to share in the illegal gains. It is reported as a known fact that bids are sometimes opened by tricky means, and in such a careful manner, that the same envelopes are used again properly, and after being sealed over, they do not show the least indication of having been so manipulated, and of course, the owners, to whom they are presented by such practitioners, have no idea of having been already so defrauded.

4. In other cases some architects may unjustly delay in giving mechanics money-orders due them for materials furnished or work done, until such architects are offered by such mechanics a high commission, either in money or its equivalent.

5. Again, some architects, in order to secure a commission on a contract, may induce and persuade the owners to build, on promises that their buildings can be put up and entirely completed for a certain sum, and before the buildings can be occupied, the owners may have to pay a great many bills for extra materials and work indispensable for the proper execution and entire completion of such buildings. Then these materials and work, which may at first have been omitted in the plans and specifications, with the intent and purpose of deceiving the owners, are charged at exhorbitant prices, and the net profits are shared between such architects and the contractors.

6. Again, some architects may give to mechanics money-orders far exceeding the cost of materials furnished and

work done; and after such mechanics have been paid they may abandon their work before it is completed, or, through negligence, carelessness or wrong intentions, these architects may not take the necessary precautions to find out whether every party having anything to do with materials, and work done for the contractors of the buildings, has been paid, or is willing to abandon through a written acknowledgment, all claims for liens on such buildings; and the owners may sometimes have to pay twice for a large portion of the work.

Some architect-builders, architect-carpenters, and other mechanics of this class, may perpetrate frauds and schemes of plunder, such as stated above, through various ways and means. They have the best opportunity to do so. with larger illegal gains, as they build according to their own plans and specifications, and have no one to superintend over them.

AGENTS AND ADMINISTRATORS OF ESTATES.

Some agents, and administrators of estates who are engaged in the interests of widows and minors, may also be involved in the frauds and schemes of plunder above stated, through the same ways and means, and share with some architects and mechanics illegal profits on a building; or they may receive from mechanics commissions of ten per cent. or more, on bills of repairs and additions to a building, over the legitimate fees which they receive from the owners.

9. All the frauds and schemes of plunder may not only exist in one or two branches of the work, but also in all trades connected with Building; they may affect, not only the general dimensions of the buildings, the height of stories, thickness of walls, general design and all details, but also the quality of materials and workmanship throughout: In foundations, stone and brick work, piers and

arches; marble and granite work, mortar and cement; Carpenter's and Joiner's work, lumber, sizes of joists, and all timbers, style and sizes of finishings—such as architraves, moldings, cornices, stairs and balustrades, wainscoting and bases, and all the hardware; Plumbing, gas-fitting and sewering; Plastering, stucco cornices and center pieces; Painting, varnish and glass, Roofing, down-spouts and gutters, and the size and weight of metal; the various kinds and qualities of all iron work or other metals: the different sizes of iron columns, pillars, pilasters, girders, lintels, and more principally the thickness of metal, which generally makes the greatest difference in the cost of the work and offers the best chances for frauds, as all of such iron or other metal work is estimated at so much a pound. Frauds may exist also in side-walks, pavements, boilers, heating apparatus, elevators, and dumb-waiters, etc., etc.

Stud or wooden partitions may be put up instead of brick walls. Good stone may be replaced by stone of an inferior quality; thickness of cut stone or ashlar, moldings and ornaments in stone work may be reduced considerably. Such reductions, both in design and sizes of cut stone, may be sometimes enormous, and of course make a great difference in the cost of the work. All the cut stone trimmings, or parts of them, as specified for doors and windows in brick work or masonry, may be omitted in buildings. Wooden cornices may be used instead of cast iron, or galvanized iron ones; cast iron, or galvanized iron cornices, instead of stone ones; gravel roofing instead of tin roofs; tin roofs instead of copper ones; tin down-spouts and gutters for copper ones; second quality lumber, instead of first quality, and third quality instead of second; a cheaper kind of wood in place of another—such as pine for oak and walnut, green lumber for dry lumber. Thick doors, sashes and blinds may be replaced by thinner ones; high wainscotings in rooms by low bases; costly finishings

by common ones; hardware of an inferior quality may be substituted for that specified throughout; common plastering for the best of plastering; stucco cornices and center pieces may be reduced in sizes, style of moldings and ornaments.

Old and second-hand materials may be substituted in place of new materials called for by the specifications, principally in plumbing, sewering, and all other secret parts of a building, which cannot be seen after the work has been done; the size and strength of lead and iron pipes, the quality of water-closets and bath-tubs, the weight of metals such as lead, galvanized iron or copper, the size and strength of iron sinks—may not always be in accordance with the specifications. The sewer pipes may not always be of the right size, or their junctions not being well cemented, may by leakage cause a settlement in the foundations and walls above, a defect which may be seen in front, rear and side walls of many buildings. There may not be always as many wash-bowls, wash-stands or sinks put in a building as indicated in the plans and specifications; paints of inferior quality may be used instead of pure white lead; common varnish and putty, instead of best materials; plain work for graining; two coats may be put on in place of three or four-coat work; one coat of varnish for two coats, with a large difference in the total cost. Glass of an inferior quality may be sometimes substituted in place of best American and French or English polished plate glass, as called for by the specifications.

The upper sash of a window may, in some places, be glazed with single strength glass instead of double glass like the lower sash. Cheap mantels, grates and hearths and marble-work, may be set in place of more costly articles specified and contracted for.

It is also reported as a known fact that commissions of ten, fifteen or twenty per cent. are paid to some agents, architects, and to some builders taking contracts on their

own plans and specifications, on the cost of mantels, grates, and hearths, and other work, such as monuments, and fancy iron work, etc. In these cases, as in others, mechanics may be imposed upon with claims of commissions by such architects, agents or builders, and submit to such illegal claims to retain their patronage and get a speedy settlement of their contracts. Commissions of one hundred dollars or more may be paid to some architects, agents, or builders, for the introduction of gas machines in country houses; large commissions may be paid for heating apparatus in buildings, for patent elevators and dumb-waiters, electric bells, any patent improvements on locks, water closets, sky-lights, etc.

It is asserted that foundations, intended to be built of hammer-dressed stone work, as specified and estimated upon by many masons, may be constructed in ordinary rubble masonry; also, that cut limestone, which was specified to be set on its natural or quarry bed, may be set on edge, with an enormous difference in the cost of materials and workmanship in both cases. It is reported that the mechanics who have been defeated in the competition, are not always invited to bid again on the inferior quality of these two kinds of work, which, consequently, may be carried out contrarily to the specifications first submitted to competing bidders.

Lastly, iron nails may be used instead of copper nails which are more costly, and part of iron anchors retaining the walls to floors and roofs, and iron stirrups for strengthening the junctions of trimmers and trimming joists to stair openings, hatchways and others, may sometimes be left out of the work, after having been specified and estimated upon.

It is also reported that very high commissions are offered and paid to some parties, for the introduction of inferior kinds of materials in preference to others which have had an established reputation for years.

Particular attention should be paid to the report that some kinds of common stone may be forced in the market and introduced into buildings through the same ways and means above stated, instead of the sand-stone or other kind of stone which after years and many experiments has proved to be the best adapted, even for the most important structures.

Judging from the above catalogue, which shows all possible chances for frauds and plunder, from the bottom stones of the foundations to the last nail, it can easily be seen how and why a house which is worth seven thousand dollars, may have cost eleven thousand; another house worth eight or nine thousand dollars, may have cost twelve or thirteen thousand; some repairs and additions which may be worth twelve thousand dollars, may have cost nineteen or twenty thousand.

It is very natural for any one who is neither an architect nor a mechanic to be entirely deceived by the general appearance of any building, as regards its legitimate cost, or to commit great errors, in being led by the appearance of the general design and external details of two buildings, when one is compared with the other, to judge their respective intrinsic value.

It is possible that two buildings of the same dimensions may be built by the same contractor, at the same time, and according to the same plans and specifications throughout, and differ considerably in cost; one may cost twenty thousand dollars, and the other, twenty-five thousand or more.

Again: Two buildings may look similar in all their parts to the eyes of the owners and others, as regards general design and details, and yet differ thoroughly in thickness of walls, dimensions in general, quality of materials, finish and workmanship. They may have been contracted for and erected by the same builder, at the same time, according to the same plans and specifications, for the same price,

and of course, through such differences in all parts and details of the work, which may not be perceptible to any one but the builder and the architect, one may be worth considerably more than the other.

Again: Two iron fronts for stores of equal dimensions, cast on the same design and details throughout, contracted for and put up by the same man, and at the same time, but for different prices on account of the different thicknesses of metal as figured in the specifications, may be worth only the same price, because the same thicknesses of metal in all parts of the work will have been used for both.

Consequently, the shrewdest men, and those who have shown the greatest ability and attained the best success in their own business, may be deceived and defrauded of large sums of money in the construction of their buildings, owing to the present defective system of transacting business.

The frauds and schemes of plunder are reported and known by a great many to be perpetrated principally by some parties among three different classes of practitioners, viz:

1. Some of those who draw out plans and specifications, and take the superintendency of buildings at very low and insignificant prices, make their money in having recourse to such ways and means of corruption.

2. Another class of men, deprived of all the necessary talent, knowledge, and professional pride, and of course raised without merit and dignity to the rank of architects, through the influence of some corrupt men or rings, only because the building business offers them an immense field of speculation and plunder.

3. Some other practitioners among architects and mechanics, who draw out plans and specifications as means to secure the contracts of buildings without the superintendency of any one over them. Of course, they can well afford to furnish such plans and specifications without

charge, having the bright prospect of making large sums out of such contracts. In many cases the extra profits they may derive from all branches of the work, and the frauds perpetrated, may be known to be sometimes enormous, consequently, the owners, unaware from the beginning, of the intended schemes of such practitioners, and feeling sure that they have secured cheap plans and specifications, may at last pay for them, through the work on their buildings, a great deal more than regular fees of architects would be.

Some of these practitioners, as well as some other men practicing exclusively as architects, already mentioned, have not followed the course or any part of the course on architecture. Like all other men, they may have vague ideas of building, and of course, being mechanics, whether they are competent or not, know more about it than others who never were engaged in any branch of the building business; but unless they have devoted the proper time to the study of the Art and acquired the necessary knowledge, they can not be recognized as architects.

Architecture is not only the first of all the Fine Arts: it is also a Science. As an Art it requires talent and originality of design; and as a Science, a long and judicious study.

Its principal objects being the safety and comfort of the individuals and society, the wants and ornament of all countries, there is no other profession, no other branch of business which possesses a larger field for display of ideas, skill and general knowledge in both of the private and public improvements.

Before entering the career of Architecture, the student must be a good scholar, show a natural disposition for the art, and make up his mind to devote his whole time to its study.

In order to practice the Profession with success, the Architect must design well and execute well; and nobody

could ever acquire the skill of designing, if he is not well acquainted with the art of drawing. I do not mean to say that every draftsman can be an architect; but it is a well-known fact that no man can be an architect, who is not a competent draftsman. It is not sufficient for the student to learn Architecture in the school; he should also devote a few years,—five or six years at least,—in a good architect's office, where he could have the best opportunity of progressing practically as well as theoretically.

Proportion, character, unity of design, and purity of style must constitute the main qualities of any building, either public or private.

The study of the Orders from the classical authors, and the modern authors, such as Palladio, Serlio, Vignola and Michel-Angelo, will teach him the rules of proportion and purity of style, even for buildings which are not adorned with columns or pilasters.

With the constant practice of designing, aided by the practical work of the office, he will not only acquire to a perfection the skill in giving character and keeping unity in his designs, but will also become acquainted with all the wants of individuals and society, and will combine economy and utility with taste and elegance.

In studying other modern and gothic styles,—following the progress of the Art in the large cities, he will improve his own originality and vary his designs.

The requirements of practice render it necessary for him to give a particular attention to the progress of buildings from their foundations to their entire completion; acquire a perfect knowledge of all the various building materials, and the mode of doing the work in all branches connected with Building.

A sufficient knowledge of Mathematics will enable him to study the principles of Construction, understand formulas, and solve problems which are based on practical experiments, and become thoroughly acquainted with all the mechanical principles.

Through this science, he can calculate the strength of materials; safely direct the construction of foundations, walls, piers, arches and vaults, roof trusses, girders and floors; he will be a safe constructionist.

Everyone should be convinced of this important truth, that no man, whether he be a draftsman or a mechanic, without this positive knowledge has the right to claim a position in the ranks of really practical men engaged in directing the construction of buildings. The safest and most important structures are erected through this science. Some of the so-called practical men who are deprived of it, after many years' experience in their own trade may be sometimes so much embarrassed in some kinds of constructions with which they were not familiar, that with all their boasted practical knowledge and good judgment, they do not know how to get out in a fair manner of their difficulties, which are puzzles to them. Having not the sufficient knowledge of mathematics to solve the problems required, they may become reckless, and either make the work cost too much by using an unnecessary quantity of materials and labor, from fear that the structure may not be safe, or, for economy, they may not give to their construction the necessary strength, and consequently cause the ruin of a building, either large or small.

These assertions are sustained by the best Architectural Schools and offices of Europe and of the United States.

As the philosopher and orator express their ideas either by writing or by speech, so does the architect express his own principally through drawing and calculations. Then, how can one possess much skill in designing, or ever acquire any culture of taste, who is not a draftsman, or never learned fully the rudiments of the art?

Some of those practitioners carry on their business only through the assistance and brains of hired architect-draftsmen; and, relying entirely on them to draw out their plans, they are never seen in their offices, like architects,

making any designs or sketches for anything. I am positive in saying, that some of these so-called practical men can not even understand thoroughly a set of plans, when completed. As to the superintendency of buildings, they may not have much to do, because the builder or each of the sub-contractors, as the case may be, generally directs his own work in such cases; consequently, some of these practitioners may not deserve much credit for any structures which may be put up in their names. Moreover, the hired draftsmen, however competent architects they may be, knowing that their patrons are not good judges in fine arts and the science of Construction, and having no reputation to establish through such practice, may be most indifferent and not give the design and the plans of the building, all the study and labor required. Therefore the owners may not always secure as good buildings as they could for the same amount or less money, if they had at first engaged a true architect.

In all the countries of Europe it is a custom, and the same custom has been adopted in this country by a great many owners contemplating building, to engage at first an architect and afterwards deal with mechanics, knowing that they can generally secure in this way much better plans, and lower bids also from the competition of the several mechanics on the architect's plans and specifications, than by intrusting one party with both the plans and the entire contract of the work. All the most important buildings and a great many private ones, either cheap or costly, are being erected under the supervision of true architects. As artists and men of practical science, having nothing to do but to devote their whole time to the study of their subject, they produce the best effects out of the skillful arrangement of all parts and the distribution of materials, and construct all kinds of work in the cheapest and most proper manner.

The profession of an architect and that of an ordinary builder are two distinct branches of business; and in all

the most civilized countries and well built cities, they are kept separate. The architect's professional duty consists principally in designing, making plans, detail drawings and writing specifications for buildings; the builder's duty is to carry out into effect such designs, plans and specifications. As a superintendent, the architect sees that the builder or the mechanic furnishes the materials and executes his work in strict accordance with the contract.

As regards men practicing either as general builders, or as mechanics in their respective branches, they are not of course all equally competent or upright. Some of them will do the most inferior kind of work, and commit some of the frauds mentioned in this GUIDE, by deviating from the plans and specifications, after having defeated in competition honest and good reputed mechanics who are ready at any time to have their work examined, and prove it to be done strictly in accordance with their contract.

Whereas, it is evident that the present system of transacting the Building Business is so defective as to offer to corrupt men, or rings, all possible chances for perpetrating the frauds and schemes of plunder stated above; therefore a radical reform is an absolute necessity; and it becomes most urgent that a better and more reliable system, which could check in all cases such frauds and schemes of plunder, intended by such corrupt men or rings, in assuring the owners that they can not be deceived nor defrauded by any ways or means, should be established at once; and moreover, for the interests and prosperity of the profession of architecture and all the mechanical branches connected with buildings, and the protection of society in general, all honest architects, mechanics, agents and administrators should coöperate with the owners in carrying out this New System in the strictest manner.

PART SECOND.

THE TRUE SYSTEM OF TRANSACTING THE BUILDING BUSINESS.

The most practical and reliable system of transacting the building business should be the following, with ways and means:

1. **The Owners should Employ Architects to draw** the plans and specifications of their buildings; and the mechanics having the contract to furnish the materials and do the work, should be placed under the superintendency of the architects.

2. **Before the Mechanics can commence Estimating** on the cost of a building, or any part of the work, in all cases and without exceptions, the owners should get in their possession exact copies of all the specifications. For costly buildings, they should have also copies or tracings of all the plans, elevations and sections, and such copies or tracings should be figured like the original drawings. Both sets of the specifications, after being compared, and also the plan of the ground floor of the building (if not all the plans) should be signed by the owner, the architect, and all the competing mechanics.

3. **Forms of Plans and Specifications.—**
For all classes of buildings, the plans, sections, and elevations, besides being drawn to a scale, should be thoroughly figured. All the general dimensions, such as

lengths, depths, widths, projections, heights of foundations, heights of all stories, cellars, attics or garrets, and general heights of buildings outside; the thickness of all stone and brick walls in all stories and cellars; the parapet walls over roofs; thickness of brick backing behind all stonework or ashlar, and filling within the depths of cornices, sizes of piers, arches, and all timbers should not only be figured on the drawings, but also in the specifications, and with great accuracy. All the various materials, and the workmanship for all classes of the work, should be fully described with particular care.

All parts and details of the cut stone work, granite or marble work: such as bases, die-courses, sills, columns, pilasters, entablatures and cornices, architraves and jambs, slabs, copings, side walks, buttresses, etc., should be figured in the specifications; the number of all the rooms in each story of the building; the number of doors, windows, blinds, with sizes and thicknesses; size of glass; different sizes and styles of all finishings in the joiner's work; sizes of stucco cornices and center pieces; number of iron columns, pilasters, girders and lintels, with their various sizes and thicknesses of metal; strength and size of all iron or lead pipes, quality of hardware throughout and the number of washstands, bowls, bath-tubs and water-closets, etc., should be mentioned in the specifications without fail.

In all cases where the owners do not secure the copies of all the plans, it is absolutely necessary that the specifications should be figured in the above manner, in order to check all possibilities of perpetrating frauds, in changing the plans, reducing the dimensions and sizes in all parts, and the number of iron columns, water-closets, wash-stands, bowls, etc., etc.

The specifications should be written in legal form, without blank spaces and erased words, and no writing should be allowed between lines. Should any changes,

additions or reductions be made in the plans and specifications while the mechanics are making their estimates, they should be mentioned on special sheets added to the specifications, and signed by all the competitors after all such estimates have been made. If the changes made on the plans affect the design or part of the design very reterially, then the bidders should stop estimating, and resume only after all of such changes have been made on the drawings and added to the specifications.

These precautionary measures will assure the owners and all the bidders that the same plans and specifications which are used for estimates will also be carried out to their exact and full extent, (unless the owners are willing to have such plans and specifications changed,) and all parties will be satisfied that the competition has been fair and just.

4. Buildings of Great Importance.—

For public buildings or private ones of an elaborate design, the principal detail drawings should be gotten out before mechanics can commence estimating, and should also be made, like the general plans and specifications, part of the basis of contract. Such plans and specifications should be drawn out and figured like others, as described above.

5. To Avoid all Possible Extra Work.

In all cases the drawings and specifications should be so complete and explicit, that after the bids are received, the owners could safely rely on the lowest bids as the exact and entire cost of their buildings, when completed; therefore, great care should be taken that everything necessary for the proper execution and entire completion of the work should be included in the plans and specifications forming the basis of contract.

6. The Owners Should Always Receive the Bids.

All the bids for all parts of the work should be addressed directly and delivered to owners.

7. Bids for Public Works.

When bids are asked for public works of any kind, there ought to be a certain day appointed to receive them. All the competitors should have the privilege of being present on that same day, and at the same hour, to deliver such bids, which should be opened then without delay, in presence of the whole Building Committee and all competitors.

If mechanics have been invited through the press, as it is generally done for public works, the contract should be awarded to the competitor whose bid is the lowest, provided that the Building Committee have fully decided to build, and such successful competitor can furnish all the securities required by law.

All the mechanics should be united in refusing to bid on any public works unless the members composing the Building Committee are willing, and bind themselves, to comply with the above rules and conditions.

8. Contract.—

In giving out the contract of any building, all the original plans and specifications, and copies of the same should be signed by both of the contracting parties, the bondsmen, and the architect. The amount of contract, with all the terms and conditions, should also be attached to the specifications. If the owners did not get the copies or tracings of the plans before the estimates were made, they would do well to secure them before the work is commenced, unless the building is to be of small dimensions or of a plain character; in such cases, the specifications, which they will have already secured, should be sufficient.

9. Changes and Additions.—

During the progress of the work, should any changes or additions be proposed, in all cases the owners should be notified; and the mechanics should not commence such changes and additions before they have presented to the architect and to the owners a bill of quantities of the materials required, with an estimate of cost; and a price should be agreed upon, for this special contract, between the owners and the mechanics.

10. The Architect or Superintendent should visit the building generally once a day, in order to have the opportunity of observing everything closely, during the progress of the work. If the building is of great importance, large dimensions, or of an elaborate design, it will be to the interest of the owner or Building Committee, as the case may be, to hire a special Superintendent or Clerk of works, to devote his whole time and attention to such building. He should be a competent mechanic, well acquainted with the practice of superintending all classes of work, and should be placed under the orders and general supervision of the Architect.

11. No Money-Orders Given without Estimates.

No money-orders should be given to contractors by architects, before a survey and detailed estimate of all the materials furnished and delivered on the building spot and of all the work done, have been presented to the owners or the Building Committee.

12. To avoid Liens on Work.—

In no case should contractors or mechanics get any money-orders from the Architect until the owners or the Building Committee have received proof that no party having anything to do with materials furnished and work done on the building, either directly or indirectly has any

more claims for liens on such building, unless the bondsmen are known to be fully and entirely responsible for their trust.

13. Final Payment.—

No final payment should be made before the work has been thoroughly examined and accepted.

14. Repairs and Alterations.—

In all repairs and alterations for which plans and specifications are needed, the same system as indicated above for buildings should be adopted; in cases of repairs and alterations which do not require any plans, the specifications are nevertheless indispensable, and should be written as complete and in the same manner and form as above stated.

15. Agents and Administrators receiving bids for buildings or any kind of work should follow the rule prescribed in Article 7, for public works.

16. Final Clause.—

No footing courses for foundations, no plumbing work or sewers, joists, girders, should be covered, and no iron columns, pilasters, girders, beams, lintels, glass, should be set up, before being approved of. Close attention should be given to all metal work, the thicknesses of which ought to be even on the whole surface, as specified for each part, also to the sizes and strength of lead and iron pipes. No hardware to be set before being submitted for approval.

The materials for painting should be brought to the building in their original packages. No coat of paint or varnish to receive a subsequent coat before being perfectly dry and examined; care to be taken that nothing but strictly pure white lead is used, when so specified.

The owners should have the exclusive privilege to select and purchase such articles as mantels and grates, monu-

ments, or all kinds of fixtures, unless they are intended to be worked out according to the architect's designs and specifications, and estimated upon by various mechanics as for all other work. The owners should also receive bids for heating apparatus, boilers, engines of any kinp, elevators, gas machines, electric bells and all other articles which are not manufactured according to the architect's plans and specifications. During the progress of the work, the owners or Building Committee should have the right to interfere at any time, or appoint anybody whom they may choose in their place to compare all parts and dimensions of the building with the plans and specifications, and scrutinize all the details and the most secret parts of such buildings, which sometimes are very costly and offer the best opportunity for injustice.

Lastly, the owners or the Building Committee should have in their power all the necessary ways and means to find out and know whether all such parts and details of such buildings, all the materials and workmanship throughout are as designed, specified, estimated upon and contracted for.

THE NEW SYSTEM OF TRANSACTING THE BUILDING BUSINESS COMPARED WITH THE OLD.

The building business is of such great importance, and involves such large sums of money, that the System of transacting this business cannot be too precise and definite for the protection and safety of the owners, architects, mechanics and the public in general; and such an important business should be transacted in all the architects' offices, with the same care and accuracy as that of a counting-house or banking-house.

Nobody can deny, when considering this New System, that it is far superior to the old one, especially in these two most essential points required: Practicability, and the ways and means of safety which it affords. It is well proved that the old system is not always reliable from the beginning, as it offers all possible chances for frauds and plunder, leads to difficulties and ruinous lawsuits; while with the New System, fair competition will take place, correct and reliable estimates will be submitted, the owners can rely on valid and legitimate contracts with the mechanics—the mechanics will know at any time the full extent of their duties, and the architects will not be losing time in adjusting difficulties between the contracting parties. And moreover, it should be acknowledged by all, that it offers the owners the best possible guarantee that in all cases their contracts with the mechanics will be faithfully carried out. Therefore, do I claim that the New System of Transacting the Building Business, as stated above and in the synopsis below, should be considered as the only practical and reliable for all parties, and should be carried out into practice until another is suggested and found to be of a better nature.

SYNOPSIS OF THE NEW SYSTEM.

1. The architects to draw the plans and specifications for buildings, and see that the mechanics furnish the materials and do the work strictly according to such plans and specifications.

2. Before estimates are made, the owners to get in their possession copies of the specifications (if not also the copies of plans). Both sets of specifications and ground plan, (if not all the plans,) to be signed by the owners, architects, and all bidders.

3. The plans to be thoroughly figured, as stated in details, and all the figures to be transferred in the specifications, with the number of rooms in each story, number of iron columns, lintels, girders, windows, doors, blinds, wash-bowls, water-closets, etc., etc.

The specifications to be written in legal form; changes, additions or reductions to be mentioned on special sheets attached to the specifications, and signed by all the bidders, after all estimating is done.

4. For buildings of great importance, the principal detail drawings to be made before mechanics can commence estimating.

5. To avoid all possible extra work over the amount of contract.

6. The owners to receive the bids from the mechanics, in all cases without exception.

7. Bids for public works to be opened immediately after being delivered, in the presence of the whole Building Committee and all the competing mechanics; the contract to be be awarded to the competitor whose bid is the lowest, provided he can furnish all the securities required by law.

8. All the plans and specifications and copies of the same to be signed by all the interested parties—the amount

of contract to be attached to the specifications. The owners to get copies of the plans before the work is commenced (if not secured before), for a costly building. When the building is of small dimensions or of a plain character the specifications are sufficient.

9. Before changes and additions can be made, a price should be agreed upon for a special contract, between the owners and mechanics.

10. The Architect or Superintendent to visit the works generally once a day. If the structure is of great importance, the owner or the Building Committee should employ a special superintendent, who should devote his whole time and attention to the building.

11. No money-orders to be given before the proper surveys and detailed estimates have been furnished.

12. To avoid liens on the work.

13. The final payment cannot be made before the work has been thoroughly examined and accepted.

14. All the rules and regulations of this New System to govern repairs and alterations.

15. Agents and administrators to open bids according to rules prescribed in Article 7.

16. The owners to have the exclusive privilege to select and purchase mantels and grates, monuments, and all other kinds of work or articles which are not executed according to the Architect's plans and specifications; and to require full proof that all the parts and details, materials and workmanship in the buildings are as contracted for.

See *details* for each article.

THE RECIPROCAL DUTIES OF OWNERS AND ARCHITECTS.

Experience teaches that owners contemplating building cannot invest money more judiciously than at first paying architects a fair price to draw out good plans and specifications for their intended structures of any class. No other subjects of art or science require more thought and study, care and attention, than the perfect design of a building, and almost every structure of any kind is for the architect a new subject of mental application.

There are grave reasons why plans should be well studied and drawn out most completely, and specifications be written in the most explicit manner: with such plans and specifications the owner can always get a fair competition and correct estimates from the several bidders; changes and additions, which will be very costly after the work on the building is begun, may be avoided; difficulties which often arise between the contracting parties may be obviated; the construction and proportions, the satisfactory arrangement and distribution of all the parts, the symmetry and beauty of the whole structure, depend almost entirely on those preliminary precautions.

It is not sufficient to draw out general plans and specifications, and furnish the mechanics copies or tracings of the same, but it is well known that the architect has to get out large-scale drawings and full-size drawings for all finishings, such as cornices, architraves, moldings, etc., which are indispensable to enable the mechanics to do and perform their work in the manner required by the contract.

When we consider the amount of study, labor and time which architects of integrity have to devote to the plans, specifications and superintendence of a building, from its foundation to its completion, and his expenses for services

of draughtsmen, etc., it should be acknowledged by all, as it is by men of experience, that the fees established by the Architects' Institutes throughout the country are no more than a just and fair compensation for their services. No man who is competent and deserves to be ranked among architects, should give his professional services at lower rates, if he intends to deal fairly with the owners in every way.

When architects are intrusted with the direction of buildings, in order to give the owners sufficient proof that they can neither be deceived nor defrauded, they should be willing to transact the building business according to the "True System," if the owners agree to pay them the regular fees of architects, and also a fair additional price for copies of plans and specifications, which constitute the principal ways and means of safety afforded by the System, when the aforesaid copies are placed in the hands of the owners before mechanics commence estimating, as stated in Article No. 2.

The architect's fees are generally from 2½ to 3 per cent. for the plans, detail drawings and specifications; and from 2 to 2½ per cent. for the superintendency; or 5 per cent. for both, on the cost of the entire work. All the plans, drawings and specifications, after having been used as instruments of service, remain the property of the architect.

RULES OF COMPETITION FOR ARCHITECTS.

Architects should only compete for public structures of any kind, and private buildings of an elaborate design and large cost, in which the owners are not supposed to be competent in making a selection consistent with the requirements of the art. They should insist also, that all the different designs be submitted for decision to one of the

best architectural schools of the country, or to a Committee of reputed architects who abstained from such competition.

This Committee could be selected in any large city of the United States. The signature of each competitor should be sealed, or replaced by a " Motto ".

It is only after having complied with such rules and conditions, and paid the premiums deserved by the most competent designers, that the inviting parties could claim the right to favor a particular friend or a relative of some member of the Committee bearing influence on the others, by intrusting him with the erection of their buildings.

If only a few architects are invited to compete, they should comply with the rules stated above, unless every competitor is to be fairly rewarded for his design.

Such a fair competition in rewarding merit, would give a great impulse to the artist's genius, raise the standard and advance the prosperity of the profession.

There should be no competition for any private building of a plain character or even an ordinary first-class residence, as for such buildings the owners generally dictate a great deal about their wants, and it must be admitted as a general rule that no architect can build cheaper than another, if both of them know their profession well and intend to deal fairly; consequently there cannot be much material difference between designs of this class; and such cases would not justify the competition of architects nor promote the interests of the owners.

Yet, if the owners insist on a competition, no architect should make any plans, sketches, or write specifications unless he is to receive a fair compensation for his work.

Architects cannot afford to make drawings of any kind without charge, except in a fair competition with the hope of getting a high premium or a commission, as stated above.

PART THIRD.

TREATISE ON

MATERIALS AND WORKMANSHIP

In All Trades Connected with Building.

REMARK.

This treatise describes fully the various qualities of the work, which are usually classed thus: Best, Good and Common. Any kind of work inferior in quality to the latter grade is worthless, and of course results in a waste of money.

It exposes and explains also in detail all the frauds which may be perpetrated in each trade, and shows all possible ways and means to detect them.

It is accompanied with all the necessary Tables and Plates.

GRANITE, STONE, MARBLE.

Granite is the best building material. Its constituent parts are *concretions* of *felspar, quartz* and *mica.* This kind of stone is only imperfectly and slowly calcinable in great heat; but being too expensive, it is not much used except for a few public buildings; Lime and Sandstones, which are much cheaper, take its place. *Hardness, tenacity* and *compactness* are the principal qualities required for all building stones. Those which are acted upon by the air, owing to several causes, are not durable. *Decomposition* and *disintegration* are the causes which accelerate their decay and destruction. The former effects a chemical change in the stone itself; and the latter, a mechanical division and separation of its component parts. The effects produced by these causes on the stones of buildings, are much modified according to their situation. The state of atmosphere in populous and smoky cities accelerates their *decomposition* more than in the open country. Some stones will crumble to powder a few years after being exposed to the air or moisture, although their power of induration seems to be very great, when first taken out of the earth; such is generally the case with that kind of stone which contains a large quantity of clay (alumine). The great affinity which clay has for water induces an absorption of moisture from the air, by which the volume of the stone tends to increase, and the aggregation of the parts is destroyed. Other stones lose much of their aggregation by the loss of water. This is the case with some marbles and the *crystallized* carbonate of lime, and with others that are composed of an acid and earth combined with water.

Limestones. — As regards *limestones,* composed of carbonate of lime, or the carbonate of lime and magnesia, either nearly pure or mixed with foreign matter in variable proportions, their *decomposition* depends upon the mode in which their component parts are aggregated. Those which are the most *crystalline* are the most durable, and burn the whitest limes; while the others suffer most from atmospheric influences.

Sandstones.—With respect to the *sandstones* that are usually employed for buildings, and generally composed of either quartz or siliceous grains, cemented by siliceous, calcareous or other matter, their *decomposition* is effected according to the nature of the cementing substance.

Decay of Stone.—The great agent of destruction of building stones is the damp, or the water supplied by the atmosphere, directly or indirectly.

Consequently, porous, absorbent stones should not be used in the ground or set on the ground, unless in the first case, they can be kept constantly wet. Porous stones should not be used for the copings, parapets, window-sills, weather-beds of cornices, plinths, strings, or other parts of a building where water may lodge.

Preservation of Stone.—After all the best precautions to preserve the stones in buildings, have been taken, yet it is sometimes necessary to protect the exposed surfaces of the soft and absorbent, with some kind of coating to prevent their absorbing the injuries of the atmosphere. This is done in various processes, viz :

1. By painting. This process is objectionable, as the oil evaporates, the stone becomes again exposed, and the frequent repetition of the process becomes costly, and destroys any delicate molded work.

2. The second process is to wash the stone with a solution of an alkaline silicate, as silicate of soda, or potassa.

This solution is able to convert the material into an insoluble non-absorbent substance, in converting the carbonates of lime into silicates of lime, through the effective affinities of the lime and the silica. This process is only applicable to the preservation of the stones in which the carbonates of lime predominate.

3. By filling in the pores of the stone with an insoluble material which should effectually exclude water. After the stone has been cleaned carefully from dust or other extraneous matters, it is made to absorb as large a quantity as possible of the silicate of soda or potassa. When this solution has dried into the stone, a second wash is applied, consisting of the chloride of calcium or of baryta. The silicate of soda and the chloride of calcium are most frequently used. This process is applied with equal advantage to limestones, sandstones, bricks, plasters and cements.

None but the best limestone, or granite, should be used for the foundations of good buildings. Care should be taken that none of that *blue clay color stone* (called *limestone*) is introduced into masonry when good work is required, especially in places where it will be affected by the action of alternate dryness and moisture; for it will soon decay and crumble when so situated.

Sandstones are generally too soft to be used for steps and pavements, and too porous and absorbent to be set level with the ground.

Marble.—The varieties of marbles are almost infinite, and their classification is, of course, impracticable.

All the varieties may be burnt into quick-lime, but some of them will fall into a kind of sand, and therefore cannot be used in a common kiln. The external characteristics are as follows :

Colors—white, gray, red, yellow and green. Marble has generally but one color, though it is often spotted, dotted,

striped and veined. In some cites of this country marble is much employed in place of stone, for fronts of buildings; but throughout the whole country it is chiefly used for chimney pieces, vestibule floors and tiling, washstands, wainscots in costly buildings, and monuments.

LIMES, CEMENTS, MORTARS, CONCRETE, ETC.

Limes. Marbles or any pure limestones produce *quick lime.* The pure limestones yield the whitest and richest limes. Limestone requires burning about sixty hours to be reduced to lime, if the heat is strong and well regulated. The expulsion of the carbonic acid gas which enters into its composition is the main object. The lime generally considered the best is that which heats most in slacking, and slacks the quickest, being reduced to a fine powder. If lime contains unslackable lumps that cannot pass through the screen, either the stone has not been sufficiently burnt, or it contained originally some extraneous matter. This is not only a defect in the quality, but it renders the lime more costly in use.

Limes are of five classes, viz: 1, The common or fat limes. 2, The poor or meagre limes. 3, The hydraulic limes. 4, The hydraulic cements. 5, The natural puzzuólana.

Rich limes are entirely dissolved in water, and do not harden without the action of the air; puzzuolana or trass renders them hydraulic. These limes shrink in harden-

ing to such a degree that they cannot be used without a large quantity of sand.

Poor or *Meagre Limes* do not increase much in bulk; the *poorer limes*, when combined with silica, have the property of indurating under water, and of course are the best adapted for the admixture of hydraulic cements or mortars.

Cements that become solid and hard under water are produced by *hydraulic limestones* containing iron and clay.

Hydraulic Limes readily harden under water.

The real hydraulic set from the 1st to the 4th day after immersion, and are known as *eminently hydraulic;* those that set from 6 to 8 days are *simply hydraulic;* others that set from 15 to 20 days, are *slightly hydraulic.* Six months after their immersion the best limes can be worked like the natural hard limestones. The strength of hydraulic limes increases when mixed with sand.

Puzzuolana, which is of volcanic origin, comprises various kinds of sands, granites, trass or terras, and other kinds of earths; which are composed almost entirely of silica and alumina. Lime in slacking absorbs a mean of 2.5 times its volume, and 2.25 its weight of water. The hydraulic limes absorb less water than the pure limes, and only increase in bulk from 1.75 to 2.5 times their original volume.

Pulverized Silica burned with rich lime produces excellent hydraulic lime.

Brick dust and *burnt clay ballast* possess some hydraulic power, when combined with rich lime.

Artificial hydraulic limes can never possess the same degree of hardness and power of resistance as the natural limes of this class.

Cements. Hydraulic cements do not slack after calcination, and are better than the best hydraulic limes. They make an excellent mortar without sand, and do not shrink in hardening.

Roman Cement, which is considered one of the best, is made of a lime found in England and France, derived from argillo-calcareous, kidney-shaped stones called *Septaria.* The very best can be used in the proportion of one part to two parts of sand. It sets very rapidly.

Portland Cement is made in England and France, from limestone and clay. The quantity of lime to clay is in the proportion of two to one. This cement is of a superior quality and can not be surpassed by any other known, to resist water, frost or other decomposing agencies. It sets slowly, and requires less water than the Roman cement.

Rosendale Cement is from Rosendale, New York, and one of the best in this country.

Ackron Cement of Ackron, Illinois, is also excellent.

The Louisville Cement is sometimes good enough for ordinary work; but it is not so well adapted as others mentioned above for outside work, or any masonry which requires strength in an eminent degree.

Artificial Cement is made of slacked lime with unburned clay.

A cement which will resist the effects of a moist climate, is composed of one bushel of lime with 15 gallons of water and ½ bushel of fine gravel sand, mixed with 3½ lbs. of copperas dissolved in hot water, and kept stirred while being incorporated and in use.

Gypsum, generally better known as *Plaster of Paris* is a sulphate of lime. It is found in England, in France and in the neighborhood of Paris, and other localities of that country; in some parts of Italy, Spain and Switzerland, also in the British Colonies of North America. The stone is broken into small blocks, and burnt in a walled space with openings in the roof to let out the steam. After its water of crystallization is driven off, it becomes pulverulent and like flour. When fresh water is added, it receives its former density and strength to a high degree. The plaster obtained from Paris is known to be the *best* in the

world, as the stone is the hardest. Its constituent parts are *acid* 46, *lime* 32, and *water* 21.

Bituminous Cements. The best are obtained from the *natural Asphalte*, which is found in abundance on the shores of the Dead Sea, in Trinidad, Albania and other places in Europe. The principal ingredient in its composition is a *bituminous limestone*, of a rich brown color. After being reduced to a fine powder, a portion of *grit* is mixed with it; then it is placed in cauldrons heated by strong fires with sufficient quantity of mineral tar to prevent the asphalte from calcining. The whole mass being thoroughly incorporated is reduced to a mastic; and in that state, it is run into moulds to form blocks, each 1 foot 6 inches square, 6 inches in depth, weighing 125 lbs.

Mortars. — Mortar composed of quicklime and sand only should be made up several days before being used. The best is three or four weeks old. It is prepared at first in large quantity, and afterwards manipulated again to become fit for immediate use. When rich limes are employed the quality of mortar is increased, if the sand is in proportions varying from 50 to 225 per cent. of the volume of the paste, according to the kind of sand and the character of limes used; but it decreases beyond this proportion.

All mortars which contain cement, should be used immediately after being mixed up, as cement generally sets very quickly. However, there are also some slow setting cements, such as the *Natural Portland*, which can be remixed with more water after 12 or 24 hours.

A good common mortar for stone and brick masonry is composed of 1 part of lime and from 3 to 5 parts of sand, (depending on the quality of the lime used, and also on the quality of masonry required).

A better mortar for masonry is made of 3 parts of cement, 1 part of lime, and 8 parts of sand.

Quality of Materials.—The sand should always be sharp and clean, and should by all means, if possible, be pro-

cured from a river or a running stream, in preference to that obtained from *pits*, as it is cleaner and not so connected with clayed or muddy particles. It is used in the proportion of 2 parts of coarse and 1 part of fine, at least for brickwork.

Mortar for brick masonry requires finer sand than that used for stone masonry, otherwise the joints would be too thick. The lime should be fresh burned, and no air-slacked lime should be allowed in good mortar. (See Cements.)

Cement Mortar.—The best cement mortar consists of 1 measure of pure cement and $\frac{1}{8}$ measure of water; and it should be used for the best work in all parts of a building exposed to water or dampness, and for walls or piers intended to support heavy weights; for towers, steeples, domes, vaults, smoke stacks, etc. However, this kind of mortar, which is very expensive can be replaced for the same purposes by another, cheaper and good enough, if composed of 2 parts of sand and 2 parts of cement, or only 1 part of cement to 2 parts of sand, especially when Portland cement is used.

Pointing Mortar.—A strong mortar for pointing is made in the proportion of 1 measure of cement to 2 measures of sand and $\frac{1}{2}$ measure of water.

Before the pointing is done, the surface of the walls is thoroughly wetted, and the joints made about $\frac{3}{8}$ or $\frac{1}{2}$ inch deep, and from $\frac{1}{8}$ to $\frac{3}{16}$ of an inch wide; then the mortar is put in by the trowel with the assistance of a straight edge: and, after it has been well calked in, and the joints well filled, it is rubbed with great pressure. The pointing should not dry very quickly, and therefore should be protected against the sun for some time in hot weather.

When lime is mixed with the cement for work exposed to *moisture,* it should be *hydraulic lime.*

Grout or *Liquid Mortar,* is nothing more than ordinary mortar mixed with a sufficient quantity of water to make it

fluid enough to penetrate into the interstices and irregularities of the interior of brick walls, which common mortar will not reach. Pure cement is the best for grouting, as for other mortars.

Mortar for cut stone work, is made of the best lime, and clean-washed fine sharp sand.

Mortar for Stock Brick Fronts.—The mortar generally used is composed of 1 part of lime and 2 parts of white sand; it makes a very fine joint, but is not strong and shrinks in hardening.

A better mortar is sometimes used, composed of 1 part of lime, 2 parts of sand and $\frac{1}{2}$ part of cement; it does not shrink and makes a joint close enough, about $\frac{3}{16}$ of an inch thick.

Black Mortar is made by adding to the ordinary mortar either lamp black or bone black, the latter is the best and will not run. Lamp black runs down and stains the face of brick or stone; but this defect can even be obviated, if lamp black and bone black be used in equal parts. Sometimes glazier's putty is mixed in the mortar for the best kind of work.

Ashes-Mortar, is made of one part of fresh burned lime, and $1\frac{1}{2}$ part of wood ashes, which, when cold must be well beaten. This mixture is superior in resisting the alternate effects of dryness and moisture, but not very good under water.

Defects *in the Use of Mortars.*—Common lime mortar used in place of cement mortar for all work exposed to weather or dampness, rots in a short time and becomes useless. Mortars composed of 1 part of lime and from 6 to 8 parts of sand, prepared and made up for immediate use (as it is often practiced) are not much better than mud, and should not be allowed in any masonry whether for a costly or cheap building. Common lime mortar may be used sometimes instead of cement mortar, and very poor cement for the best, as called for by the specifications.

Concrete, is a mortar composed of coarse sand, gravel or broken stones, etc., mixed with cement or lime, or both. Rounded pebbles of gravel are not so good as small angular stones; but fragments of brick or burnt clay are excellent. The firmest concrete contains no lime, and when mixed in the right proportion of the best cement, it is so strong that it can be used in place of masonry, which is more expensive, for many other parts of a building besides foundations and walls. Europe furnishes a great many examples exhibiting the excellent quality of concrete in some buildings over one thousand years old, where arches and domes have been built with that material. Now, it is principally used for foundations on soft soil.

Good Common Concrete, is composed of 1 part of quick lime, and from 6 to 8 parts of gravel, coarse sand, and small broken stones or fragments of brick.

Hydraulic Concrete is composed of 1½ parts of unslacked lime, 1½ parts of sand, 1 part of gravel and 2 parts of a hard broken limestone (McAdam).

Best Concrete foundations: 1 part of cement, 2 parts of sand, 5 parts of small clean broken limestones, (McAdam). In all cases the sand should be clean.

FOUNDATIONS.

For all buildings, after the trenches or pits have been excavated to their first intended depth, the soil should be well tested before the masonry walls can be started. The foundations to be most guarded against are *bog-earth*, *soft clay* and *made earth.*

If the tests indicate that the soil lying under the level of the trenches is not firm enough to support the walls of the structure, then the best remedy is to dig down to the *solid bottom* in several places along the trenches, and either carry up piers of sufficient strength to support the building, by throwing arches across from one to the other, at the proper height for the lowest story, with buttresses at the angles to withstand the thrust of the arches, or build solid walls of masonry. But if the depth be so great as to render this impracticable, we must have recourse to some artificial means of support.

If the soil is not softened by water running through it, the trenches should be dug much wider, and from two to six feet deeper (according to the strength of foundations required by the weight of the walls), and then filled to their entire width at the bottom with *concrete* in the following manner :

After the lime has been mixed with the sand, stones, etc., water is added to slack the lime ; and the whole being quickly mixed together on a platform provided for that purpose, is either deposited into the trenches and rammed down with heavy rammers, or thrown into them from a height of from 12 to 15 feet. When it has hardened, it becomes a *safe foundation* for the building.

Before the concrete is laid, the bottom of the trenches should be saturated with cement mortar so as to prevent

the water in the concrete from washing away. After the foundation is completed, the concrete should be covered with sand four inches thick at least, to prevent it from drying too fast, and keep the bulk of the concrete more uniformly moist.

If the soil is naturally damp, it is a good precaution to use cement or hydraulic lime in the concrete instead of common lime, to resist the effects of dampness and avoid any possible settlements. Layers of coarse gravel or small broken stones are good enough and may be substituted for the concrete in many places.

Concrete Foundations have been used for many large buildings with complete success. Those of the London University and St. George's Hospital in England, and the New Chamber of Commerce of St. Louis, are striking examples of their safe, sure and superior qualities. For, although the ground on which these buildings were erected was very soft and partly intersected with old sewers and cesspools, and partly on clay, there is not the least appearance of unequal settlements in any part of them.

For uneven foundations, the common practice of building up masonry walls by steps is not so safe as the use of *concrete* for bringing up the irregularities of the soil to a level. This last means is more effective than the former in preventing any unequal settlement in the walls.

In all cases, when a *soft* and *unreliable ground*, exposed to running water, overlies a firm one, at such a depth that the excavation of trenches and erection of walls or piers would become troublesome and dangerous, *Piling* is the safest foundation that can be adopted.

Piles should be made of very sound timber: either oak, elm, yellow or white pine, or spruce: straight and round, free from bark and projecting stubs, from ten to eighteen inches diameter at the top. They are driven into the ground at a distance of three or four feet from centre to

centre, by means of a heavy hammer raised at a considerable height with machinery.

The best foundations are known to be *rock*, *gravel* and *stiff dry clay;* yet the most experienced architects and other constructionists of all ages advise us not to trust them too hastily; for, although they may resist the *pick-axe,* they may either be weakened by cavities or underlied with very soft ground only a few feet below the level of the trenches, which may cause the ruin of the building. Therefore, if the excavation of deep cellars or wells in the neighborhood has not already given a positive evidence that the ground is reliable to a considerable depth below the level where the walls were intended to be started; then after having levelled off the trenches all around, it is a good precaution to test it at different spots by boring or digging holes from 5 to 8 feet deep (depending on the weight of the intended structure). If the soil is solid to that depth it will be safe to proceed at once with the masonry; for a *stratum* of firm ground of that thickness should be considered just as strong, at least for any ordinary or even a heavy structure, as any artificial foundation, such as concrete, which is laid over soft and unreliable soil for supporting heavy edifices, as stated above.

The practice of building masonry walls on *wooden platforms* or *planking* is dangerous; for if the timbers are not constantly kept thoroughly wet, they will rot in a short time, causing very alarming settlements in the walls. Such foundations should not be used except for light and cheap buildings, and then the timbers should be well coated with tar before they are laid; yet the walls, however equal their settlements may be in appearance, are always expected to *crack* in a short time.

STONE MASONRY.

Foundation Walls. Before the work can be started, the bottom of the trenches should be levelled off, and rammed with heavy rammers; if the masonry is built on concrete foundations, the surface of the concrete should be perfectly cleaned off and thoroughly wetted before the mortar is spread to receive the *footings.*

Footing Courses. To commence the masonry by first laying a *footing course* all round, which is generally the only one used for houses and other buildings of ordinary dimensions. For heavier structures, several *footing courses* are laid as shown by diagram (Fig. 1), their number being regulated by the weight of the walls; each of them decreases in breadth as they rise by sets off on each side of from 6 to 12 inches, and should reach across each course from one side of the wall to the other. When the walls are so thick, that it becomes difficult to secure all the stones long enough for that purpose, then every second stone in the *footing course* may be a whole stone in breadth, and each space filled with stones of equal width. When stones of a length equal to the breadth of the *course* can not be procured, it is proper and necessary to alternate the *headers* and *stretchers* on both sides, so that the whole *course* may be well and thoroughly united in the direction of its thickness. All the *footing stones* should be square, of the same thickness in the same course, and placed with their broadest bed downwards. The *footings* should be laid so that the joints of any *course* may fall in the middle of the stones below. Each stone should be thoroughly wetted before setting, and settled with a heavy wooden rammer. The stones in the first *course* should be

solidly bedded in the soil, so as to have no rocking tendency. In damp soil, the outside face of *footings* should be pargeted up from top of concrete with hydraulic lime mortar $1\frac{1}{2}$ inch in thickness at least; the *pargeting* is to make a close and water-tight connection with the concrete and become sufficiently hard before filling in.

Joints of Footings. The joints should be close, not over one inch open, for the best work, and flushed full of mortar; no chips or spawls (small broken stones) should be allowed either between stones, or for the purpose of pinning up or leveling stones in the work. All stones should be laid in the same direction or bed as they lay in the quarry.

Walls. The walls that are erected on the top of *footing courses* are sometimes, but very seldom, built of large dimension stones partly running through their whole thickness, and dressed either on both sides or one side only. They are most generally built of *rubble work*.

Rubble Work. This species of work is of two kinds, called *coursed* and *uncoursed.*

Coursed Work. The *coursed work* is the best of the two; all the stones used are gauged and dressed by the hammer, laid in courses on a perfect level. This kind of masonry is built either in regular courses called *regular range work*, or in *irregular and interrupted courses* with stones of different sizes called *random range work* or *broken range work.* All stones should fit so closely as to avoid interstices large enough between them to require filling with chips or spawls (small broken stones). The joints should not exceed 1 inch in thickness.

Care to be taken to make all parts of the walls of equal solidity by filling well their inner joints both horizontally and vertically.

In Regular Range Work no second course should commence before the lower one is fully completed around the whole building (as a general rule).

This kind of work being very expensive is not often used in foundation walls except for public buildings and some large and costly houses. *Coursed work* should always be built instead of *uncoursed work* when strength is required in an eminent degree. The walls above the ground are often faced with *coursed work.*

Uncoursed Work. In the uncoursed work the stones are laid in the walls as they come to hand, being prepared only by knocking off the sharp angles with the hammer. This kind of work, when built with care is good enough for all ordinary purposes. All interstices in the walls are to be filled with *chips* or *spawls* and mortar pressed in to a solid consistency; care to be taken to make all parts of the walls of equal solidity.

Bond. To lay in the walls a sufficient number of bond stones having an excess of length, and not of height to bind the work and make it uniformly compact. For the best kind of uncoursed work, there should be a bond stone running through the thickness of the walls at every superficial yard, (when the walls are not unusually thick). All quoins and angles, window and door jambs, that have no cut stone trimmings should be built with large stones hammer-dressed laid alternately in headers and stretchers.

Piers All stone piers should be built in regular courses; the stones may be rough on their faces, but they should always have their beds dressed so nicely as to lay perfectly level and form an even joint on the whole surface.

Inverted Arches. For heavy buildings, when piers are built in place of solid walls of masonry, unless they rest on rock, it has been a practice from an early age to turn at the bottom *inverted arches* as shown by diagram (Fig. 2), for distributing the weight equally throughout the length of the foundations, in order to prevent accidents or unequal settlements, which may otherwise occur from uneven bearing.

Arches. All stones for arches to openings should have

their *beds* dressed, and cut so as to have the joints drawn from the point of radius by which the arch is described.

All the stone used in the foundation walls should be the best limestone, if not granite. For the best kind of work all stones are laid in the walls in the same direction or bed as they lay in the quarry.

Filling In. As soon as the walls can permit, the trenches all around should be refilled with earth so as to protect the masonry against water, which may wash away the mortar and soften the masonry. The earth should be put in wet, and rammed down to a solid consistency, as it is being deposited.

Work Overground.—The walls built overground with Ashlar facing are backed either with rubble masonry or brick. Fronts of houses in many cities of this country generally consist of a sandstone ashlar front from 4 to 8 inches in thickness, backed with brick; sometimes the limestone is used in place of the sandstone. There are no bond stones in the wall, the ashlar being anchored to the brickwork with iron anchors. This kind of work requires a good quality hard brick laid in cement mortar, and yet is not so good as a wall built entirely of either brick or stone would be. When a wall is built of stone masonry and faced with ashlar (cut stone), if the piers between the openings are narrow (as often seen, especially in store fronts,) they can be made either of one solid piece, or laid in several pieces, each piece running through the wall. If the piers are wide, every alternate jamb stone should go through the wall, and the number of bond stones between the jambs must be proportioned to the width of the pier. Bases and caps of pilasters or piers, and keystones (centre-pieces of arches), as much as possible, should go through the wall. In some buildings the walls are built entirely of cut stone.

Bond Stones should not be spared in long courses below and above windows; and their horizontal dimension

should never be less than the vertical one, otherwise they would produce a bad effect to the eye.

Various Styles of Stone Cutting.—The various kinds of ashlar or styles of stone cutting used are the following:

Rough-hammered with a tooled or cut margin, as shown by diagram (Fig. 3); Bush-hammered or fine-dressed, as shown by diagram (Fig. 4); Droved Ashlar, as shown by diagram (Fig. 5); Chamfered Rustic, as shown by diagram (Fig. 6); Revealed Rustic, as shown by diagram (Fig. 7); Rustic with a tooled margin, as shown by diagram (Fig. 8), this applies to both chamfered rustic and revealed rustic; Range-work with a rustic face laid in regular courses, as shown by diagram (Fig. 9); Broken Range-work, or Random range-work with a rustic face, as shown by diagram (Fig. 10). The last is more principally used for gothic buildings, and the best adapted for churches of the early or decorated gothic styles. Another kind of Ashlar, which is a medium between the rough-hammered and the bush-hammered or fine-dressed, is called Picked face Ashlar.

There is also another style of cutting called the Vermiculated; as the term indicates, it represents the face of a stone attacked by worms. It should not be introduced into buildings, because stones cut in that style are supposed to be rotten stones.

Notice.—The term "bush-hammered" is applied to limestone or granite only. The limestone or granite work is sometimes chiselled vertically after being bush-hammered, on costly buildings.

Sandstone is dressed and rubbed. Limestone and granite are also rubbed sometimes, and when of the best quality, can be polished almost as fine as the best marbles.

The terms of other styles of stone cutting stated above apply to all kinds of building stones.

Mortar Joints.—Should the mortar set flush with the face of the stone, it is to be raked out to the depth of half an inch for pointing, which must be done when the stone work is cleaned off.

The joints should not be more than $\frac{3}{16}$ of an inch thick for nice work.

Drips and Water-Joints.—All the cut stone projections to have the necessary throatings and drips to throw off the water. The abutting joints of all projecting stone-work exposed to weather should have water-joints bevelled each way, and the joints well filled with cement. The metal gutters coming in contact with stone cornices should have flashings let into the stone and cemented with iron filings and linseed oil.

Joints of Columns.—All columns, bed of bases, neck of columns, and other joints, should form a smooth, level joint, not more than $\frac{1}{16}$ of an inch thick, and sheet-lead should be used.

Fluting of Shaft of Columns should be done after setting, when composed of many pieces, so as to make it more regular and perfect on the whole height.

Beds and Builds.—The beds and builds of all cut stone work must be cut full to the square and left free from all defects. The dressing of all stone to be evenly done and so true, that after two, three or more are laid one above the other, each surface shall be true to the face line.

Back of Stone Work.—The back of all the stone work connected with brick-work, should be roughly pitched off to lay evenly with the brickwork. Whenever stone quoins are used in brick-work, each piece of stone should conform in height with an even number of bricks laid in, so as to avoid cutting bricks.

Cleaning and Pointing Stone-work.—All the cut stone to be washed perfectly clean before setting. After the stone-work is completed and the building covered, the stone-work should be cleaned off and pointed.

Floors of Porticos are usually laid in large stones with a perfect water-proof joint made of molten lead.

Vault Floors may be of sawed limestone, marble, tiling, brick, or thick slate, laid in cement mortar.

Sidewalks.—The best sidewalks made are of limestone or granite; some others are made of composition stone, and brick with a limestone border (curb stone).

(See the different kinds of mortar for masonry.)

Precaution Against Accidents.—Care should be taken that some *careless plumbers* do not excavate under masonry walls, to make their sewer pipe connections, as it occurs sometimes. This practice, which often causes cracks and settlements in the walls should not be tolerated. The right time for making sewer pipe connections is before the foundations are built; and if they are not made then, an opening arched over should be provided for that purpose. The architect or the mason should never forget to see that the *plumbers* have always the junctions of the pipes well cemented, so as to prevent leakage, that may injure the masonry.

Defects in Masonry.—Very inferior masonry is sometimes built against the *true principles* stated above and carried out by honest and competent architects and mechanics. The defects are the following: 1. In the foundations, the footing stones in the same course are not all of the same thickness and of the form required, nor laid so as to break joints with those of the course below, as they should be. These defects will sometimes cause cracks and settlements in the upper structure. 2. There is not a sufficient number of bond stones laid in the walls, and longitudinal joints are made on a great length, which are dangerous. The stones are not laid in to a solid consistency, and mortar is often used only on the outside edges. The interstices between stones in the uncoursed work being not always filled with spawls or chips (small broken stones) and mortar, large holes are left in the walls. These defects often cause the

walls to crack, bulge outside as shown by diagram (Fig. 11) and sometimes crumble.

Walls built in this manner have been seen *split* into parts after the buildings had fallen down; one part hanging outside, and the other inside, as shown by diagram (Fig. 12).

Owners, who build on speculation should be as cautious in intrusting reputed honest and competent masons with their work as when they put up buildings for their own use; for, if the masonry be too defective, the effects will soon be apparent; and a building, however safe it may be, cannot be sold but at a considerable loss, when its walls are cracked.

An other great *fault* is to lay the limestone *edgewise,* instead of laying it in the same direction or bed as it stands in the quarry, in all parts of a building which have to carry heavy weights. Stone laid *edgewise* loses much strength; it cannot resist half as much pressure as when laid on its *natural bed* in the building (flatwise). It cracks vertically and may crumble under a comparatively moderate weight. Sand stone set *edgewise* loses also much of its strength. However, for private buildings the stones are generally set on *edge,* except the bases resting on the ground, the steps, door and window sills, belt courses, which are usually laid on their natural bed. For public buildings as for private ones, the ashlar or cut stone work for fronts backed with brick or stone masonry is generally set *edgewise,* at least from the top of base or level of first story floor. Cornices and all other projecting parts and quoins are usually set on their *natural bed;* the stones for bases from the line of the ground to the level of the first story floor, at least for public buildings, are generally set on their natural bed also. Columns and pilasters, except when made in many pieces are of course, set *edgewise;* but their bases are laid on their *natural beds.*

Great frauds are reported to be perpetrated sometimes by setting the stone *edgewise* instead of *flatwise* (or its nat-

ural bed) as illustrated by diagrams (Figs. 13 and 14), either when strength requires the stone to be so laid, or when stone set edgewise is sufficiently strong; in the latter case the specifications are exaggerated so as to lead some mechanics astray in their estimates, in order to defeat them in the competition and yet secure an opportunity of making an immense profit, viz:

Remark first, that the cut stone is estimated at per cubic foot. Now, suppose that pieces such as bases, quoins, etc., of any dimensions—say the dimension of that represented by diagram (Fig. 13), are specified to be set on their natural bed, estimated upon and contracted for; see the amount of cubic feet in this piece: 4 ft. long by 2 ft. deep in the wall = 8 ft. by 1 ft. 6 in. high = 12 ft. cubic, of stone.

Remark also, that we have to go about 20 or 22 inches deep in the quarry to procure a piece of this thickness when cut and laid, which is expensive and sometimes difficult.

Then, some architects and mechanics may deviate from the contract (this has been sometimes practiced), by reducing the depth of each piece in the wall, as shown by diagram (Fig. 14), which represents a stone of the same surface as diagram (Fig. 13), but 1 foot less in depth; and this is set *edgewise,* which may crack vertically after a short time, as shown by the diagram.

In committing such a *fraud,* they produce the same external effect with the *weak stone* (Fig. 14), as they would with the *strong stone* (Fig. 13), *and no inexperienced persons can detect it.*

Now, let us see the amount made through this *daring robbery:* Stone (Fig. 13) contracted for contains 12 cubic feet as stated above, and stone (Fig. 14) which is used, being of the same surface, but 1 ft. less in depth, that is to say 1 ft. instead of 2 ft. deep, has only 6 cubic feet. Therefore one-half of the cut stone is saved, besides much labor,

as we have to go only 14 or 15 inches deep in the quarry to procure a piece of 1 foot deep laid in the wall *edgewise.*

Frauds have been perpetrated in a larger proportion than this illustration. As a witness and a man of many years' experience, I may know and have been told many times that stone 6 or 5 inches instead of 30 inches deep in the wall has been used contrarily to the contract.

Many thousand dollars may have oftén been acquired in such illegitimate ways and means, only in the cut stone work laid from the level of the ground to that of the first story floor, and the *owners* or the *public* who were only attracted by the *appearance of the surface,* never suspected of being *so defrauded.*

Other frauds reported to be perpetrated in the stone work by deviating from the plans, specifications and the contract are the following: 1. Ordinary rubble masonry or *uncoursed work* is sometimes built instead of best kind or *coursed work.* (Both kinds are described above). 2. A stone of an inferior quality is used for the best. 3. To reduce the thickness of walls, the quantity of cut stone, change the style of cutting and the members of molded work, as stated already in the first part of this GUIDE.

(See Mortars).

BRICK AND BRICKLAYING, TILING, SEWERS, ETC.

The best brick earth is composed of pure clay and sand, deprived of pebbles of every kind, but particularly of those containing lime and pyritous or other metallic substances. The earth is well tempered and squeezed into a mold; and when so formed, bricks are stacked to dry in the sun, and finally burnt to a proper degree of hardness in a clamp or kiln. Brick is one of the most important, and the very best, fire-proof building material.

The bricks generally used are *Hydraulic Press* or *stock brick;* and other *machine* or *hand-made brick.* Both are classed or graded in the same order, viz: *red* and *hard, dark red* and *light red.*

The ordinary *red* and *hard* consists of *hard, light,* and *dark red.*

Strictly hard and *red* consists of *dark red* and *hard.*

There is also the *merchantable brick,* which is partly *salmon* and partly *red* and *hard.* The *salmon* is a soft brick, and used only for some inside work. No soft brick that can soon dissolve in water should be allowed in the walls. In ordinary houses the merchantable brick is used none but red and hard of uniform color being laid externally.

All walls intended to support heavy weights; the backing of stone fronts; chimney-tops, and all work exposed to dampness, water and the weather, should be built exclusively of hard bricks laid in cement mortar. The top of fire-walls, or other walls exposed to the weather should also be laid with hard brick in cement mortar, about 18 or 24 inches down below the surface. No brickwork should be

started level with the ground externally (as it is often practiced); for brick is a great conductor of dampness, both up and sideways, and does not resist long the effects of the alternate action of dryness and moisture. Brick should be laid at least 12 or 15 inches above the level of the soil. All bricks should be thoroughly wetted immediately before being set in, except in freezing weather; then they should be kept dry. The bricks should be entirely cleaned out of dirt and dust, because mortar will not adhere well to any but clean bricks. All the walls should be carried up straight to a line and plumb.

Fire-brick, which can sustain a very high degree of heat, is used for the facing of ovens, furnaces, fire-places, etc.

Bond.—There are four different ways of connecting the bricks together in walls:

1st. *English bond* is a disposition of bricks in a wall (except at the quoins) wherein the courses are alternately composed of *headers* and *stretchers*, as shown by diagram (Fig. 15). This is a very strong bond.

2nd. *Flemish bond*, is that wherein the same course consists alternately of *headers* and *stretchers*, and is equally as good as *English bond* except at the angles. See diagram (Fig. 16).

Two American Methods of Bond.—In the first every brick is a *stretcher* in all courses laid externally (except at the quoins), as shown by diagram (Fig. 17). At every 7th, 6th or 5th course, the facing bricks are chipped on the inside at each corner, so as to allow some of the backing bricks set on the same level diagonally to lap over the facing course below, in order to form a bond. This bond, which is used principally for nice stock-brick fronts, is rather weak, and should not be used when strength is required to an eminent degree.

In the second, the courses are laid in *stretchers*, with the exception of every 5th, 6th, or 7th course which is laid in *headers*, or alternately with a *header* and a *stretcher;* the last

way of the second method is very weak, and should be used only for cheap and light houses one-story high.

Brick-Nogging is a method of constructing a wall or partition with a row of posts 3 or 4 feet apart, whose spaces are filled up with a few plates of wood and brick work between. It is generally the width of a brick in thickness, and the bricks and timber are flush.

Half-brick Partition.—A half-brick partition built in common mortar is adopted in a great many lodging-houses of the cities of England, with an occasional hoop-iron bond. These are built four, five, and six stories in height; the apartments being small, only 12 ft. long, 9 ft. wide, and from 9 ft. to 9 ft. 6 in. in height. This kind of partition could be safely introduced for larger apartments of higher stories, if it is built of well-formed hard brick laid in good cement mortar.

Tiles laid in cement with plugs to receive the dressings, make a good partition, and take less room than a wall $8\frac{1}{2}$ inches thick.

Hollow-walls are often built, consisting of an outside-wall $8\frac{1}{2}$ or $12\frac{3}{4}$ inches thick, 2 inches space, and 4 inches inside-lining, tied with the outside wall by means of cross-bricks laid at every two or three courses vertically, and about every two feet horizontally.

Fire-proof Ceilings are made of either one brick or one-half-brick arches, resting at each side on iron beams laid about four feet apart, the bricks to be set in cement mortar,

Anchors.—Brick walls are anchored to floors and roofs with strong iron anchors.

Paving with brick is done over a 4 or 6 inch layer of gravel or sand, which should be free from clay, and well consolidated. The ground should be well graded off before the work is commenced. The bricks are laid either *flatwise* or *edgewise*. When the paving is done, if the joints have not been made in mortar, sand is brushed into them.

Tiling of clay or marble is laid on a coat of cement mortar about 1 inch thick.

Terra-Cotta made of clay and burnt, is used for chimney tops on houses. There are two kinds of chimney flue-pipe: straight and round; these flues are made from a mixture of pure fire-clay and free silica; they do not rust or decay. Chimney thimbles, 5, 6, 7, 8, and 9 in., of various lengths.

Drainage is divided in three classes: *Drains, Sewers,* and *Culverts.*

Drains are the small courses leading from one or many locations, to a sewer.

Sewers are courses leading from a series of locations. *Culverts* receive the discharge of sewers. In culverts less than 6 feet in depth inside, the brick-work should be $8\frac{1}{2}$ inches or 1 brick thick; if from 6 ft. to 9 ft. in depth, it should be $12\frac{3}{4}$ inches or $1\frac{1}{2}$ brick thick. The oval and egg form are the best for culverts. Their inclination should not be less than 9 inches in 100 feet, when possible, although sometimes they fall only 6 or 7 inches in that length.

Drain-pipes, made of stoneware, are from 3 to 30 inches diameter bore (inside), in parts of 2 feet long to the socket; they should be inclined about $\frac{3}{8}$ or $\frac{1}{2}$ inch to the foot; and their junctions should be made perfectly water-tight with the best pure cement, and afterwards the pipes should be filled around to 3 or 4 inches high with a course of sand.

Joints. The joints are of the following various thicknesses: $\frac{1}{8}$, $\frac{3}{16}$, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$ of an inch. They should not be more than $\frac{3}{8}$ inch thick for the strongest work, nor exceed $\frac{5}{8}$ for common work. The brick work loses much of its resisting power when laid in very thick joints.

Steel-joint.—The stock-brick which is used only for nice fronts is laid in joints of from $\frac{1}{8}$ to $\frac{3}{16}$ of an inch thick, drawn with the steel jointer.

Struck-joint.—The struck-joint is drawn by the point of the trowel,

Flush-joint.—The flush-joint is drawn even with the face of the brick, but the top can be trimmed with the point of the trowel; it is the best joint and most durable, as water can not go in and break it.

Remarks about Joints.—All the joints, both horizontally and vertically should be thoroughly filled with mortar for good work; every course is to be flushed with mortar, and the brick slid into position, thus receiving a coat on all faces; no empty joints are left in the best kind of brick-work. For surfaces intended to be plastered, the joints should either be left open or cut out rough, so as to give a strong hold to the first coat of plastering.

Grouting.—The work in thick walls should be grouted thoroughly with a kind of liquid mortar at every course, when strength is required in an eminent degree.

Arches, to openings, etc., should be turned with strong hard brick, and molded arch brick should be used for nice and strong work.

Drains or *Sewers,* passing through or along the walls should be arched over with brick, in the best work.

Bed-plates, to be set perfectly level, and true with the face of the brick to receive the ends of joists, beams and girders for each story.

Smoke-stacks and *Flues.*—Smoke stacks for boilers may have an inside lining of brick tile with 2 inches of air space between tile and brickwork; the tile to be securely fastened to the brick wall with galvanized iron anchors. The smoke flues should be coated with cement mortar or wash, to the top of chimney shaft.

Foul Air Flues.—The walls of foul air or ventilating flues should have the inside joints struck smooth, pargeted with cement, and floated to an even surface with a brush. The wash should be made out of the best cement and fine sand, and put on at the same time the bricks are laid, in order to set properly on the damp brick work, to be not less than $\frac{1}{8}$ of an inch thick.

Cisterns, built of brick should be plastered inside with two or three coats of hydraulic cement. When the walls are laid, two inches thick of cement should be put in between earth and brick, so as to prevent any water from penetrating through the walls and damaging the plastering inside. To have the proper overflow to sewer, and a trap to prevent the return of foul air from the sewer to the cistern. The cisterns should be either domed or arched, with a cast iron neck and cover in the center, or covered with stone slabs, slates or brick arches resting on iron beams; the joints should be made perfectly tight so as to prevent dust from falling in.

Vaults.—Vaults are either built with hollow walls, or ventilated with a five inch hollow tile; the openings being connected with ventilating flues, and by introducing a current of air on all sides, and through the floors and ceilings, so as to keep the vaults free from dampness. Vaults have sometimes heating flues opening inside. When the vaults are arched over, instead of being ceiled with iron beams and brick arches between, the side walls are sometimes secured by means of wrought iron bolts to resist the thrust of the arch, and passing across the space over head, generally on the level of the springing of the arch.

Covering and Cleaning Walls.–All walls should be covered and thoroughly protected at all times from the weather. When the work is completed, the outside walls should be cleaned off and left free from any defects.

Well-burnt bricks will ring when two are struck together.

Thickness of Walls.

A wall	$4\frac{1}{8}$	inches	thick	=	$\frac{1}{2}$	brick
"	$8\frac{1}{2}$	"	"	=	1	"
"	$12\frac{3}{4}$	"	"	=	$1\frac{1}{2}$	"
"	$17\frac{1}{2}$	"	"	=	2	"
"	$21\frac{1}{2}$	"	"	=	$2\frac{1}{2}$	"
"	$25\frac{3}{4}$	"	"	=	3	"

(See Mortars).

The dimensions of brick vary so much, that a table of the exact sizes of bricks of all the various manufactures becomes impracticable. The Philadelphia, St. Louis, Baltimore and Wilmington front press brick, is from $8\frac{1}{4}$ to $8\frac{1}{2}$ inches long, by from 4 to $4\frac{1}{4}$ inches wide, by $2\frac{3}{8}$ inches thick.

Notice.—Owners should do well to use entirely hard brick in good houses instead of that merchantable brick, ($\frac{1}{8}$ salmon or soft brick). It costs only very little more a thousand, and makes much stronger work.

Spring and Fall are the best seasons to do brick masonry.

The frauds reported to be perpetrated sometimes in brick work by deviating from the plans, specifications, and the contract, are the following:

An inferior quality of brick is used; the walls are built thinner than figured on the plans and in the specifications submitted to competing mechanics; the work is not done in a substantial manner; the joints are made too thick, and the vertical joints are not filled with mortar.

PLASTERING.

Lathing.—All stud or wooden partitions, furred-walls and ceilings, soffits of stairs, etc., are usually lathed with sawed white pine laths 4 feet long, and about $1\frac{1}{2}$ inches wide by $\frac{1}{4}$ inch thick, nailed up horizontally on the stud, partitions and furrings, and should not be laid less than $\frac{3}{8}$ or $\frac{1}{2}$ inch apart to give a strong key to the mortar. Laths 1 inch wide are the best, and for first-class work they are laid so that each one breaks joint with the other. The work is very good also when the joints are broken at every fourth or fifth lath. The most durable laths are made of cedar; but being too expensive, they are not much used. Iron laths are employed for ceilings of fire-proof buildings, when the plastering is not put on the brick arches. Before being laid, they are thoroughly wetted with lime-water to be preserved from rust.

Wetting and cleaning.—Before the brick walls are plastered, their surface should be thoroughly wetted, brushed or broomed with water for removing the dust off and preparing the brick to receive the first coat of mortar.

Plastering.—The plastering in the interior of buildings, whether done on wooden partitions, ceilings, brick or stone walls, consists of three coats of mortar for the best kind of work, although two coats only are often put on brick walls.

First Coat.—The first coat, which is rough and called the *scratched coat*, is laid in good mortar usually composed of 1 part of quick-lime, 3 parts of sand, and $\frac{1}{6}$ part of cow-hair, which is used to render the mortar more cohesive and less liable to split off. (This is often the only coat used in rude buildings and cellars.) After this coat has slightly

dried. it is deeply scratched with a pointed stick or a lath, in diagonal lines from 1 to 2 inches apart running across each other: this is intended to give a strong hold to the second coat.

Second Coat.—The second coat called the brown coat may be put on with the same kind of mortar; but for this the proportion of hair may be slightly diminished. Before it has dried hard, it should always be roughed over by a broom, or floated, to render the third coat more adhesive to it.

Third Coat.—The third coat contains no hair, and is either of stucco, or guage stuff (hard finish).

Stucco is a gray finish composed of 1 part of fine-stuff or pure lime-putty, and from 2 to 3 parts of sand; it is the best finish for walls proposed to be painted in oil, or papered.

Fine-stuff is pure lime-putty. Lump lime is slacked to a thick paste with a small quantity of water, diluted to the consistency of cream; it afterwards hardens by evaporation to its required consistency.

Skim or Slipped Coat.—If the putty is mixed only with a little sand, it is called *skim* or *slipped coat*, instead of *fine-stuff*, being only the smoothing off of a brown coat, so as to make the surface more even; for cheap buildings this finish is good enough when the surface is intended to be painted or papered.

Guage-stuff or Hard-finish, consists of 1 measure of plaster-paris to 2 or 3 measures of fine-stuff. The plaster-paris is used to hasten the hardening, and works easier than stucco. This finish is generally adopted. For the best work a small quantity of fine, clean, sharp sand, washed through a sieve, should be mixed in the hard finish stuff, to produce a smoother and firmer polished surface.

Two-coat work.—Sometimes, for economy, only two coats of plastering are put on ceilings and stud partitions. For this kind of work, as for three coat work, the first coat is of the same kind of hair mortar, and after having been

scratched, it is covered by the finishing coat. This kind of plastering is very poor; it will soon crack and peel off.

Experience teaches that it is true economy to have always three coats of plastering, even for cheap houses.

Materials.—The quality of plastering depends considerably on that of the sand used; the best is clean, sharp river-sand, and should always be used, if possible, for good work, and in the proportions of 2 parts of coarse, and 1 part of fine. White sand is not so good as river sand; the former cannot make so strong work as the latter, and will cause the plastering to turn yellow after a short time. The lime should be fresh burned, and no air-slacked lime should be allowed in good work. The hair should be fresh-slaughtered winter-killed long hair.

Best work.—The best kind of plastering can be made when the first and second coats are composed of 1 part of good cement and 3 parts of ordinary mortar, especially if the sand be washed well before being used in the mortar.

Granulated work.—Nice imitation of some kind of stone can be made with good effect, by putting on only two coats of plaster mixed with fine clean bright gravel instead of the sand. This kind of work is most suitable for churches, halls, station-houses, etc.

Manner of Doing the Work.—All the ceilings are to be made true and straight; the walls and angles true and plumb; the ceilings should be first coated by going twice over them at once: the first time across the laths, and afterwards, lengthwise; the second coat is put on light, and the finish is of its usual thickness.

Screeding.—In order to prevent or rectify all irregularities and undulations of the plastered surfaces on all brick or stone walls, (and sometimes on wooden partitions) which are always uneven and out of a perfect line, *Screeding* must be employed as a guide: *Screeds* are *strips* of the same mortar used, about 6 or 8 inches wide, to be laid on the first coat at every 4 or 5 feet all around the room (or

nails may be driven to a perfect straight line for that purpose). They have to project to the intended face of the second coat, being straightened both horizontally and vertically by means of the straight edge and plumb line. When they are dried, the inter-spaces are filled with the second coat brought flush with the face of the screeds.

Each coat should be hand-floated to become firm and strong; the finishing coat is polished with the trowel, the hand-float and the brush. When the plastering is not intended to be painted or papered, a float of cork is used for finer polishing. In no case should a subsequent coat be put on before sufficient time has been allowed for the precedent one to become thoroughly dry. The scratched coat should be well wetted with a sponge before applying the second one. The unworkmanlike manner of doing plastering by following one coat after the other before moving the scaffold should not be allowed on the best kind of work. The mortar used for plastering in first and second coats should be prepared at least 3 or 4 days before being used, and the water added in small quantity in tempering it up. All the mortar should be kept under cover.

Pugging.—The pugging or floor *deafening* over brick arches in fire-proof buildings or for wooden floors, is composed of small pieces of broken brick, stone and coarse mortar, thoroughly mixed with plaster or water lime. Cinders from blacksmiths' shops and foundries mixed with hair mortar are excellent, and lighter than the former mode.

Cornices and *Centre-pieces* are of sizes proportioned to the dimensions of the apartments or rooms and the height of stories; they are either plain, molded or ornamental. All the ornamental work should be executed in bold relief, clear cut, and the sinkage free and sharp. The cornices and coves should be formed as light as possible, for the plaster used for that purpose is heavy. When cornices of large dimensions are run, *wood* or metal *bracketing* must be

provided, and on this the plastering is formed. The work is run with wooden molds, having zinc or copper edges, to give the general outline of the cornice. The enrichments are cast in plaster-paris, and afterwards fixed with the same material and firmly secured with screws or other means.

Thickness of Plastering.—In the best work, the first coat is from $\frac{3}{8}$ to $\frac{1}{2}$ inch thick (exclusive of the thickness of laths); the second $\frac{1}{4}$ to $\frac{3}{8}$ of an inch thick; the third or finish, about $\frac{1}{8}$ inch in thickness. On even surfaces the three coats should not be less than $\frac{7}{8}$ of an inch thick, and with the lath $1\frac{1}{8}$ inch in thickness. Plastering $\frac{3}{4}$ inch thick makes fair work; but under this, it is very poor (exclusive of the lath).

The frauds reported to be perpetrated sometimes in plastering, by deviating from the specifications and the contract are the following:

Very inferior work throughout a building is done instead of good or best quality; common sand and air-slacked lime may be used in place of good or best materials; sap-wood laths are often used, and laid on carelessly and too close together; a sufficient quantity of hair is not put in the mortar; the necessary length of time is not spent in working on each coat; a subsequent coat is put on before the previous one is dry. Some of these defects make the plastering crack and peel off.

Again, two coats may be put on instead of three coats; to save material, each coat may be laid much too thin; the finishing coat, which ought not to be less than $\frac{1}{8}$ inch thick, is not much better in some places than lime wash. The size and style of cornices, centre-pieces and ornaments may be reduced considerably.

It is also reported that in some buildings, all the cornices around ceilings, centre-pieces and ornaments, after after having been contracted for at first with the plain plastering for a certain sum, may have been either omitted

entirely, or charged again as extra work, and of course paid twice by the owners, who, having not paid a *sufficient attention* to the specifications, never had any idea of being so defrauded.

Marble Imitation.—Nice imitation of marble of any color can be produced in plastering with *stucco*, in the interior of buildings. There are two sorts of *stuccos:* those made of limes, and those made of plaster. The former has already been described; its color being too disagreeable to the eye, it is not used for ornamental decorations. The latter is made of lime, mixed with chalk, plaster, calcareous powder, and other substances; it produces in a short time a solid surface, which may be colored, painted, and polished so perfect, as to resemble polished surfaces of marble.

In Italy, *stuccos* are executed in three coats; the first is very coarse; the second is much finer, and contains more lime. The last consists of rich lime, which has been slacked and run through a very fine sieve; it stands from four to five months, so that every particle can be reduced to a hydrate. When the lime cannot be kept for that length of time, the slacking is helped by beating it up. Gypsum (plaster of Paris) and alabaster are used, when great perfection is required; (powder of Italian marble is sometimes employed.) It is colored by mixing with the lime metallic oxides, etc., such as required. The excellence and beauty of the work depend on the care taken in imitating the effects of the natural marbles. When plaster is employed instead of lime, it is guaged with *lukewarm* water, in which *size* or *gum* has been dissolved, in order to fill up the pores to give more consistency, and make it capable of receiving a better polish. Any of the colors used, is dissolved in the *size* water. When the work has become dry, the surface is rubbed with *grit* stone, and polished up with rubbers in the same way as marbles. The thickness of a coat of this stucco varies from $\frac{1}{6}$ to $\frac{1}{8}$ of an inch.

Carton-pierre and Papier-mache.—In Europe, and in France

more principally, ornaments made of *carton-pierre* and *papier-mache* are very much used instead of plaster or other kinds of decoration. The former is composed of whiting (same kind as used for glazier's putty) and glue (very little glue). *Papier-mache* is any kind of rotten paper (rendered rotten with acids) mixed with a little whiting and glue squeezed into a mold. These compositions are light; and ornaments of all sorts, such as flowers, leaves, center-pieces, brackets, etc., are made of them. They can be fixed to walls or ceilings with screws more safely than ornaments made of plaster. They are used in some of the finest buildings. The interior of the State Capitol at Springfield, Illinois, has been partly decorated with these two kinds of composition.

Method of using Hydraulic Cement for fronts of buildings.—For old buildings, clean off all the old mortar or oil mastic; rake the joints at least half-inch deep; wash the surface well with lime-water to remove the oil, as cement will not adhere to oil work. For first-class work, the surface of the brick work should be hacked, but it is a very expensive and tedious work. Use New York Rosendale, or Portland cements, and the best river sand. After the sand has been well washed in a tub of clean water, to separate the clay therefrom, 2 measures of the clean and sharp sand which is left, are to be mixed with 1 measure of cement. Two coats are to be put on. The first should be a scratched coat, as for inside work. The surface of the wall must be well saturated with water before the cement is applied.

In hot weather, sprinkle the front with water, after the cement is put on, two or three times a week for about two weeks.

If sugar or molasses is added to the water for mixing the plaster, in proportion of 1 lb to 8 gallons of water for the first coat, and 1 lb to 2 gallons of water for the second coat, it is said to improve greatly the quality of the plaster.

Imitation.—Nice imitation of granite can be made on fronts according to the following process: After the second or smooth coat of plaster is dry, it should receive one or two coats of lime-wash, with a light tint of umber, ochre or red, etc. Before this is dry a wash of lime and mineral black is to be sprinkled upon from a flat brush, for imitating the spots of granite. After the whole is dry, the joints, both horizontally and vertically, are drawn perfectly by a brush and the same black-wash, with the assistance of a long straight edge.

WOOD, TIMBER, ETC.

The kinds of wood most generally used in buildings, are White and Yellow Pine, Oak, and Black Walnut; some other kinds, such as Cedar, Spruce, Elm, Ash, Chestnut, Birch, and Mahogany, are also employed, but in small quantity.

White Pine, which is principally used, is light and soft, has a clear, straight grain, and stands the weather well enough.

Yellow Pine is stronger, but not so easy to work, nor can it resist the atmospheric influences, or dampness from the soil, as well as White Pine. It is principally used for timbers of floors and roofs, flooring and steps of stairs; but it should never be employed for outside work, or basement floors. It makes beautiful joiner's work for the inside of houses, and can be used for this purpose in place of hard wood when secretly nailed, as it can be polished and varnished without paint.

Oak of good quality, is more durable than any other wood which is procurable of a similar size. When green, it is not so strong as when thoroughly dry. Knots weaken it very much; and all cross-grained pieces should be rejected. It is rarely dry two or three years after it is felled, warps and twists very much in seasoning, and shrinks about $\frac{1}{35}$ part of its width. Oak is the best and strongest timber for floors, roofs, and stairs. It is rarely employed for inside or outside finish, except in a few public buildings.

White Oak is stronger, and stands the weather better than Red Oak; but being found in larger quantity, the latter is more used than the former, for the timbers of buildings.

Oak, being very expensive, is not much employed, and Pine being much cheaper takes its place.

Walnut, a native wood of Persia, is of a rich brown color, less liable to be affected by worms than any other timber, Cedar only excepted. From its brittle and cross-grained texture, it is never used for the timbers of a building, such as girders, joists, rafters, etc.; it is principally employed for stair-balustrades, and also for the joiner's work of costly buildings. It is never used outside, for it does not stand the weather.

Cedar possesses a great durability, and is not subject to worms or vermin. It is very straight in the grain, works easily, and splits readily. It will not rot for a great many years; but it is too scarce to be used much in buildings.

Spruce is tough, and difficult to work; it is much used in some places for floor and roof timbers, and also for flooring.

Elm has a rough and dark colored bark; its wood is ruddy brown, very fibrous, hard, flexible, and of a dense appearance, subject to warp, tough and difficult to work. Being subject to the attack of worms, it is not much employed in carpentry, except in default of better, for work above the ground. When constantly wet it is exceedingly

durable: and of course is very much used in wet foundations, for the keels of vessels, piles, and in water-works. It shrinks about $\frac{1}{14}$ of its width in seasoning. There are fifteen species of Elm.

Ash is white, and veined longitudinally with yellowish streaks; being hard and heavy, tough and elastic, and well fit for resisting sudden and heavy shocks, it is principally used for carriage wheels, handles of spades, axes, and tools. It is sometimes employed in houses for wainscots and panels of doors, or other paneled work, and produces a nice contrast with dark woods, such as Black Walnut.

Chestnut is a wood of great durability, and has been much used in Europe for the timbers of roofs of some important buildings. However, it cannot be trusted like some other woods, as it is sometimes well-looking outside, when decayed and rotten within. Its color resembles so much that of Oak, that one timber is often mistaken for the other; but the difference is, that the pores of the sap-wood in Oak are larger and more thickly-set, and easily distinguished, whilst those in the Chestnut require magnifying powers to be distinguished. It is not very susceptible of swelling and shrinkage, and is much easier to work than Oak. It is used in some places in this country for finish in joiner's work.

Birch excels in straightness, freedom from knots, has a deep, warm color, and a beautiful grain. Being very hard, it is very suitable for floors and stair-cases. It is employed in some places for joiner's work, and sometimes connected with Chestnut, Ash and Black Walnut to produce a greater contrast in the various parts of the work.

Mahogany, which is a native wood of the West Indies and the country round the Bay of Honduras, is the best wood employed for veneers. It is usually sold at per foot superficial, 1 inch thick. It holds with glue better than any other wood, and takes a very high polish with hand-labor. It is much used for furniture work, and sometimes for stair-balustrades and doors in houses.

Inspection of Timber.—We can judge the quality of timber in some degree by its color. If it is sound, the color is nearly uniform in the heart, a little deeper towards the center.

Sap-Wood is known by its white color; it is next to the bark, and very soon rots.

Dry Rot is indicated by yellow stains.

Common Rot is first indicated by yellow spots upon the ends of the pieces, when piled, and a yellowish dust in the checks and cracks.

The defects of wood or timber are *splits, cracks* and *checks* extending towards the center; if strongly marked, the timber is not fit for general use.

Brash-Wood is generally that of a tree on the decline from age; it is porous, and breaks short without splinters.

Twisted Wood, the grain of which winds spirally, is not fit for service in buildings.

Knotty Timber is that containing many knots, though sound; large, loose, dead or decayed knots weaken timber very much.

Belted Timber killed before being felled, or dead from any other cause; it is not serviceable for building purposes.

Wind-shakes, are circular cracks which separate the layers of wood from each other. It is a most serious defect.

The best timber grows in a dark soil intermixed with gravel. The best time for felling timber is in mid-summer (July) and in mid-winter.

The *soundness* or *decay* of timber is recognized at once, when struck a quick blow. If timber is exposed to the air and dried, after having a long time been immersed in water, it becomes *brashy* and *useless.*

Seasoning.—The gradual mode of seasoning is the most favorable to the strength and durability of timber; but various methods have been introduced to hasten the process. Steaming timber has been applied with success.

The various processes of saturating wood with a solu-

tion of corrosive sublimate and antiseptic fluids, is very satisfactory. This process secures wood from rot and the attack of worms, while hardening and seasoning it.

Kiln-drying is serviceable only for boards, planks, and pieces of small dimensions, and is apt to cause cracks and to impair the strength of wood, unless performed through steam in a most careful manner.

Impregnation of wood according to the following processes:

1. Kyan, 1832. Saturated with corrosive sublimate; solution, 1 lb. of chloride of mercury to 4 gallons of water.

Burnett, 1838. Impregnation with chloride of zinc by subjecting the wood endwise to a pressure of 150 lbs. per square inch; solution, 1 lb. of the chloride to 10 gallons of water.

Timber drying gradually, requires from 2 to 8 years to become thoroughly seasoned; it should be worked as soon as it is perfectly dry, as it deteriorates after that time.

Preservation of Timber.—All timbers which are exposed to the action of alternate dryness and moisture, should be protected by the application of some substance impervious to moisture. All kinds of timber should be perfectly dry before being covered with paint or any other substance. Painting is highly injurious to any but seasoned wood; it prevents the drying of the inner part, the effects of which are fermentation and a rapid decay. A mixture of pitch and tar is known to be a good preservative; sanding, which is sometimes done on the last coat of paint for outside work, is very effective in the preservation of wood. The saturation of timbers with any of the oils is excellent against vermin; and the use of nitric is also well recommended. The introduction of air to the timbers of a building is the best protection against rot and worms, when they lay dry and free from moisture.

Warmth, especially when coöperating with moisture, generates *dry rot.* Lime, and dampness of new brick-work

receiving the timbers, are great agents of decay to the ends of them. This can be obviated by inserting the ends of the timbers in an iron shoe, or covering them with a thin piece of iron, or with tar. Wood laid in sandy soil is well preserved against rot.

Cure of Dry Rot.—A weak solution of vitriolic acid with water will generally stop the rot, if it has not gone too far. Coal-tar is also good, but owing to its unpleasant odor, it cannot be used in houses.

Bending of wood is effected in the five following ways :

1. By using the heat of a naked fire.
2. By the softening influence of boiling water.
3. By softening with vapor.
4. By softening it in heated sand.
5. By vapor under high-pressure.

LUMBER.

When the wood is prepared for service and introduced in the market, it is called *lumber*, this is the general mercantile term. The different dimensions usually on hand in the lumber-yards, are the following:

1	inch	thick	by	10 or 12	inches	wide.
$1\frac{1}{4}$	"	"	"	10 or 12	"	"
$1\frac{1}{2}$	"	"	"	10 or 12	"	"
2	"	"	"	4, 5, 6, 8, 10, 12, 14, 16 inches wide.		
$2\frac{1}{2}$	"	"		of the above dimensions may be found sometimes, but scarcely.		
3	"	"		is very seldom on hand.		

The length of boards, 1, $1\frac{1}{4}$ and $1\frac{1}{2}$ inches thick, is from 10 to 18 feet.

The length of pieces of from 2x4 to 2x8 in. is from 10 to 20 feet.

Pieces of from 2x8 to 12x12 in. are usually from 12 to 24 feet long.

Some other dimensions may be found; but as they are not generally kept in stock, they have to be specially ordered, when wanted.

Lumber 1 inch thick works $\frac{7}{8}$ of an inch thick; $1\frac{1}{4}$ inch works $1\frac{1}{8}$ inch; $1\frac{1}{2}$ inch works $1\frac{3}{8}$ inch; 2 inch works $1\frac{3}{4}$ inch; $2\frac{1}{2}$ and 3 inch work $2\frac{1}{4}$ and $2\frac{3}{4}$ inch.

Lumber 3 inches thick is generally of the best quality.

A great many various qualities of lumber are used in buildings; and every state or city has its own method of grading lumber.

CARPENTER'S AND JOINER'S WORK.

All the lumber employed for carpenter's and joiner's work should be of a sound description, free from sap, shakes, large and loose or dead knots, or other serious imperfections. That portion required for the joiner's work and all the finish in good buildings should be perfectly free from any knots, either small or large, and all other defects, and it should also be thoroughly seasoned. For good buildings, all the timbers for floors and roofs, such as girders, joists, posts, studs for partitions, rafters, tie-beams, etc., should be perfectly dry, when they can be procured, for dry timbers are of a great service to a building in the way of preventing cracks through the inside work, and plastering especially.

Flooring.—The best flooring is made of boards of from $2\frac{1}{2}$ to 4 inches wide, by $\frac{7}{8}$ or $1\frac{1}{8}$ inch thick, called battens, grooved and tongued; another kind of flooring is made of boards of from 5 to 7 inches wide, of the same thickness, also called battens, grooved and tongued; another made of boards of from 8 to 12 inches wide, generally laid rough. In some buildings, $1\frac{3}{8}$, $1\frac{3}{4}$ and $2\frac{3}{4}$ inches dressed, and $1\frac{1}{2}$, 2, and 3 inches rough flooring are used. Good flooring is laid so that the battens break joints with each other, (no two joints should be together) and each piece is secretly nailed to the joists.

For the best kind of work, the surface of the flooring, after being laid, is smoothed with the plane; but this is a long and tedious work. When flooring is to be covered with carpets, it is made of white pine; if not to be covered, yellow pine being the strongest is used.

Doors, Sash and Blinds.—Inside doors, sash, and outside blinds are usually $1\frac{3}{8}$ and $1\frac{3}{4}$ inch thick for dwelling-houses or other ordinary buildings; $1\frac{3}{8}$ inch sash is used only for common houses; and $1\frac{3}{4}$, $2\frac{1}{4}$ and $2\frac{3}{4}$ inches for public buildings.

Front doors are usually made of $2\frac{1}{4}$ or $2\frac{3}{4}$ inch stuff. Good folding doors, or sliding doors inside, when double, are $2\frac{1}{4}$ or $2\frac{3}{4}$ inches thick. They are sometimes made in two thicknesses, and this makes the best work. Common houses have generally front doors $1\frac{3}{4}$ inch thick. Doors in gothic churches are sometimes 4 or 5 inches thick.

The doors are usually paneled on both sides, having two, three and four panels or more, in height, depending on the size of the opening, and also on the style of the building. Some doors are paneled on one side only, the other side being made of narrow battens laid vertically. This kind of doors is not often used in houses. The inside shutters for dwellings are $1\frac{1}{8}$ inch thick; and $\frac{7}{8}$, $1\frac{1}{8}$, $1\frac{3}{8}$, $1\frac{3}{4}$, $2\frac{1}{4}$ and $2\frac{3}{4}$ for others; those in dwellings being partly made with rolling slats and partly paneled.

Stairs.—The risers of steps to stairs are $\frac{7}{8}$ or $1\frac{1}{8}$ inch thick, the treads or level parts of steps are $\frac{7}{8}$, $1\frac{1}{8}$ and $1\frac{3}{8}$ inch thick; treads to outside steps are sometimes $1\frac{3}{4}$ inch thick.

Board Partitions are usually made of $\frac{7}{8}$ boards, and sometimes $1\frac{1}{8}$, $1\frac{3}{8}$ and $1\frac{3}{4}$ inch thick; they should not be more than 5 or 6 inches wide, grooved and tongued; the best are made of battens 3 or 4 inches wide.

Finishings are of different styles, sizes and thicknesses.

Hence, the necessity of having all parts of the work, doors, sash, blinds, stairs, and all the finish fully described.

Full size detail drawings for cornices, bases, architraves, moldings, etc., become indispensable to enable mechanics in making accurate estimates for the work.

Corrugated ceilings and linings against walls, which are generally used in some stores instead of plastering, consist of narrow boards or battens with a strip 2 or $2\frac{1}{2}$ in. wide and $\frac{1}{4}$ or $\frac{3}{8}$ inch thick molded on edge to cover the joints.

Bond timber and grounds are laid in the stone or brick walls to receive the wood finishing, such as bases, wainscoting, jambs and architraves, etc.

Bath-rooms and *Water Closets.* Bath-rooms should be wainscoted all around with narrow beaded battens capped over. In good houses the seats of water-closets should always be double, with a lid-cover hinged, and made of hard wood (walnut is generally used). The riser should be made so as to be easily removed, in case the plumbing work should need some repairs.

Kitchens to be wainscoted.

Closets to have the necessary shelving and hooks.

Wardrobes.—Stationary wardrobes are sometimes made of either black walnut or cedar, which are vermin-proof; they do not run up to the ceiling, and are finished at the top with a neat cap. When made with taste and care, they are well fit for first-class houses, and do not take so much space as plastered closets.

Pantries and china-closets are fitted with the necessary cupboards, drawers and shelves.

Sills of hard wood, under all the doors are fixed to the floor with screws.

Deafening Floors.—In good buildings, where the floors are not fire-proof, they should always be deafened by another flooring laid about half-way between the top flooring and the ceiling. It usually consists of 1 inch rough boards laid at each end on strips of wood of about 1½x2 inches, nailed to the sides of the joists; it is covered with some kind of mortar. (See Pugging or Deafening in Plastering.)

In first-class buildings, the door and window frames are not set until after the roof is put on, and the wood flooring is laid only after the plastering is done.

Each member of the finish in the joiner's work is properly sand-papered off. When the work is put together, all the joints should be close, and the whole finish show well defined and clean lines in every member; the plastering should always be thoroughly dry before putting on the finish.

The edge of window-casings and door-frames should be so protected, while plastering is being done, that they will be clean and square to receive the architrave, which is to be well backed out before being put up. The base on one side of the partitions which contain sliding-doors, should be so arranged as to be easily removed in case of repairs needed for the proper working of the doors.

The carpenter and joiner are usually required to protect all projections and corners of stone work, and furnish all centering for turning arches; to do all the necessary jobbing work, and assist the plumber and the gas-fitter in cutting holes through floors and partitions for pipes, etc.

Frame Buildings are built with an outside frame, made of scantlings or studs, 2x4 and 2x6 or 2x8 inches, laid vertically, resting on a thick sill, and notched at every story above, to receive plates laid edgewise on which the joists

have to rest; the studs are usually laid 16 inches apart, with rows of cross-ties laid horizontally at every 4 feet in the height. They are covered outside, first with a sheating of narrow boards $\frac{7}{8}$ of an inch thick, grooved and tongued, papered over with a thick brown paper to make it perfectly air-tight, and afterwards finished with another thickness of narrow boards laid horizontally, lapping one over the other (called siding or clapboard;) the corners are finished with pieces of from 4 to 9 inches wide, and about $1\frac{1}{8}$ or $1\frac{3}{8}$ inches thick.

A frame finished outside with boards of equal widths laid vertically, and strips or small battens to cover the joints is sometimes built; but it is not near so durable, nor can it render a house so comfortable as the former method.

The Frauds reported to be committed sometimes in both carpenter's and joiner's work by deviating from the plans, specifications, and the contract, are the following:

Very unsound timbers, such as girders and joists for floors; posts, studs for partitions, and rafters, etc., for roofs, and also lumber of an inferior quality in the joiner's work may be used, especially in the window and door frames, whose defects are sometimes hastily covered with paint. The window frames should always be inspected before being painted.

Very common flooring may be laid in instead of good or best quality.

Remark.—When specifications call for first quality or clear lumber, every piece found in the work so specified, with only one small knot or other slight imperfections, is apt to be rejected.

Unseasoned lumber may be used for dry lumber in any part of the joiner's work.

A wood of an inferior kind has been used sometimes in place of another; it is reported that pine has been employed in some buildings in place of black walnut, for some

portions of the joiner's work. Doors, sash and blinds are sometimes made thinner than those specified.

Balustrades to stair-cases have been made in some buildings much lighter and cheaper, than those specified.

Lumber in flooring and in the finish, is often reduced in thickness.

Wainscots of from 3 to 6 feet high, have been replaced by bases of about 10 or 12 inches high. Very light finish, such as moldings, architraves, bases, etc., have been used, instead of heavy finish, as called for by the specifications

IRON.

Iron is the most abundant and useful of all the metals, and is found in almost all parts of the world.

Ore.—Iron is extracted principally from the argillaceous ore, or clay iron-stone.

Manufacture.—There are three kinds of iron manufactured, viz: 1. *Cast Iron;* 2. *Malleable* or *Wrought Iron;* 3. *Steel;* both *Cast Iron* and *Steel* being certain compounds of iron with *carbon.*

These products contain many foreign substances, such as Sulphur, Phosphorus, Silicon, Antimony, Calcium, Magnesium, and also Arsenic and Copper, which are very poisonous. The strength and other qualities of the various kinds of Iron depend principally on the absence of these impurities.

After the ores have been selected and separated as much as possible from heterogeneous substances, they are roasted

in large quantity in the open air, to be freed from the Sulphur and Arsenic they contain. Bituminous coal is used for the roasting. The ore is afterwards transferred to the *crushing mill* for pulverization, and then carried from the *mill* to the *smelting furnace* to be converted into iron. Therein it undergoes two separate processes: first, the *oxide* is reduced to a metallic state; the second process is the separation of the earthy particles in the form of *Scoria*. The ore which is generally mixed with certain fluxes, is submitted to the action of carbon at a very high temperature, in furnaces (called *blast furnaces*). The fusion of the ores is effected by vitrifying the earths mixed up with the *oxide* of iron. Pure limestone, or magnesia limestone, is employed as a *flux*.

The iron when run out from the *blast-furnace* is in the state of *Cast Iron*, (Pig Iron) which is far from being pure, having a coarse grain, and being brittle. It is converted into *Malleable* or *Wrought Iron*, by undergoing one of two processes; either charcoal or coke being used. In the first case, the pig iron is melted in a furnace resembling a smith's hearth, and herein fused three times in about three or four hours. The iron which is again solid, is taken out of the furnace, and very slightly hammered, to free it from the *Scoria*; after this it is once more introduced into the furnace, in a corner whereof it is stacked, out of the action of the blast, and well covered with charcoal, where it is allowed to remain until it has become compact enough to bear the *hammer*, which is of a large weight, and moved by *machinery*. It is then beaten till the *cinders* are forced out and the particles of iron become welded together. Then it is divided in several portions, which, by repeated heating and hammering, are drawn into bars, in which state it is ready for sale.

There are various modes of procuring the *blast;* the practice at the present day is to force the air into the furnaces at a temperature ranging from 600 to 800 degrees Fahr.

The proportion of pig or cast iron from a certain quantity of ore, varies as the difference in the metallic contents of different parcels of ore and other circumstances; the quantity of *bar* or *wrought iron* obtained from *pig iron* is not valued at more than 20 per cent.

The other process for manufacturing bar iron, is conducted in *reverberatory furnaces*, usually called *Puddling Furnaces*. The operation is commenced with the fusion of the pig iron in refining furnaces, like the one above described; after the *refining* is finished, the metal is formed into balls, and condensed under the *rolling* cylinder. From this state it is brought into *Mill bar iron*. After this operation, several pieces are welded together, from which it acquires ductibility, uniformity and cohesion. This process is generally adopted in England, and also in this country. *Malleable* or *Wrought Iron* is often obtained from the *ore* directly by one fusion, if the metallic oxide be not too much mixed with foreign substances.

Wrought or Malleable Iron in its perfect condition is pure, or nearly pure; and is distinguished from others by the property of *welding*. When two pieces are raised nearly to a white heat, and pressed or hammered firmly together, they adhere so as to form one piece. Before being welded the surfaces should be perfectly clean and free from oxide of iron, cinder, and all other foreign matter. Wrought iron if not very pure, becomes granulated, when exposed to a constant heat, even of low temperature; therefore none but the very best kind should be used for that purpose.

Boiler Plates.—The iron required for boiler plates should always be manufactured from the best ore. The test consists in heating red hot and cooling in cold water. If it holds its tenacity, it is good; if not, it is bad and should not be used for boiler plates. The plates are termed *sheets* when under $\frac{1}{4}$ inch thick; *plates*, if from $\frac{1}{4}$ inch to 2 inches in thickness; *slabs,* when more than 2 inches. The plates most generally used, are from $\frac{1}{4}$ to $\frac{3}{4}$ of an inch thick.

The strength and tenacity in bar iron are indicated by a fine, close, and uniform fibrous structure, with a clean, bluish gray color and a silky lustre on a torn surface where the fibres are shown. The best kind of plate iron consists of alternate layers of fibres crossing each other, which ought to be nearly of the same tenacity in all directions.

Rolled Iron is *Wrought Iron*, passing while hot through different grooves in rolls (called *puddle rolls.*)

Sheet Iron and *Hoop Iron* are generally *rolled iron.*

Corrugated Iron is sheet iron rolled into the form of a series of waves; it is sometimes used between joists to carry concrete, for fencing or for stiffening frame work. The flutes are generally about 5 or 6 inches from center to center.

Notice.—Corrugated iron is very effective in checking the rapid progress of fire in floors, and is very much used in England and other parts of Europe for this purpose. It should also be employed in this country more than it has been in the past.

The quality of iron is improved by reheating, and repeated rolling or hammering.

There are several varieties of *Cast Iron;* the principal divisions are *Gray* and *White. Gray Cast Iron* is produced at a high temperature with a large quantity of fuel. A low temperature and a deficiency of fuel produce *White Cast Iron.*

Gray iron is of different shades of bluish gray in color, granular in texture, softer and more easily fusible than *White Iron*, which is silvery white, brittle, and excessively hard. The differences between these kinds of iron depend on the proportions of carbon in them. *Gray Cast Iron* contains 1 per cent, and sometimes less, of *carbon* in chemical combination with the iron, and from 1 to 3 or 4 per cent of *carbon* in the state of *plumbago* in mechanical texture. That kind of Gray Iron which contains the greatest proportion of *plumbago* is the softest and the weakest.

Gray Cast Iron is the best adapted for all building purposes; it is generally graded thus: No. 1. No. 2. No. 1 makes the finest and most accurate castings; but for plain strong work, both are used mixed together, and No. 2 in a larger proportion.

Gray Iron yields easily to the file when the external crust is removed and is in some degree malleable and flexible in a cold state. Its fracture is of a brilliant gray, and sometimes of a bluish-gray color which is lighter as the grain becomes closer: and its hardness is increased at the same time.

White Iron, although harder than *Gray Iron* is too brittle to be safely employed for building purposes, especially for columns, pillars, girders, or any other large piece of a structure. It is not much used except to be converted into *Wrought Iron.*

Gray Iron is more soluble in acids, and also more subject to rust than the *White Iron.*

White Iron resists the file and the chisel; and generally takes a high polish; its fracture is of silvery white, fine-grained and compact, it is very sonorous and brittle.

A good quality of iron is indicated by a medium-sized grain, bright gray color, a close compact texture, and a fracture sharp to the touch.

Mottled Iron is a mixture of Gray and White iron.

A good test of the quality of *Cast Iron* is by striking the edge of a piece with a hammer; if it makes a slight impression, denoting some degree of malleability, the iron is of a good quality, when uniform; if fragments fly off, the iron is hard and brittle. Good iron breaks like a piece of good *pine;* bad iron will break like a *carrot.* Iron, whether *wrought or cast*, ought to be as little exposed as possible to sharp blows and rattling vibrations. In all iron work which is to sustain shocks and vibrations, abrupt variations of dimensions and angular figures should be avoided, as fractures are apt to commence at the angles.

The thickness of castings used for building purposes varies generally from $\frac{3}{8}$ to $1\frac{1}{2}$ inch. The thickness of wrought iron is not usually less than $\frac{1}{4}$ inch.

Steel, the hardest and strongest of all the products of iron, is a compound of iron with from 0.5 to 1.5 per cent. of its weight of carbon. These are acknowledged by the best authorities to be the only essential constituents of *steel.*

Lower grade, or Semi-Steel is a compound of iron with less than 0.5 per cent. of carbon. It is intermediate in hardness and other properties, between steel and malleable iron.

Steel can be hardened by sudden cooling from a high temperature, and softened by gradual cooling. The elevation of temperature previous to the gradual cooling can be produced by plunging *steel* into a bath of a fusible metallic alloy, ranging from 430 to 450 degrees Fahr.

Steel is made by various processes: 1. Carbon is added to *Malleable Iron* in making steel for cutting tools, and other fine purposes. 2. Carbon is abstracted from *Cast Iron* for making great masses of steel and semi-steel in a short time and at a moderate price. The processes are the following:

Blister Steel, made by cementation; bars of the best wrought iron are put in layers of charcoal, and exposed for several days to a temperature of about 9,000 degrees. Each bar absorbs carbon and is changed into steel.

Puddled Steel is made by puddling pig iron and discontinuing the process at the moment when the proper quantity of carbon remains.

Shear Steel is made by breaking bars of blister steel into lengths, faggotting them, and rolling them out at a welding heat; the process is repeated until uniformity of composition and texture has been nearly obtained. This steel is used for tools and cutting implements.

Steel made by the *air-blast* is produced from *molten pig iron* by *Bessemer's process*, wherein after the iron has been run into a suitable *vessel* or *converter*, jets of air are blown

into it through tubes as the liquid is poured in; the oxygen of the air becomes combined with the silicon and the carbon of the pig iron, and by this action produces sufficient heat to keep the iron in a melted state till it is brought to the malleable condition; it is then run into large ingots, which are hammered and rolled in the usual way. About two hours are sufficient to convert cold iron into pure steel.

Cast Steel is made by melting bars of blister steel with a small additional quantity of carbon (in the form of coal tar) and some manganese. Another process, requiring a higher temperature, is to melt bars of the purest malleable iron with maganese and the necessary quantity of carbon. The quality, as to hardness, is regulated by the proportion of carbon. Cast steel is the purest, most uniform and the strongest steel, and is used principally for the finest cutting instruments, and the best adapted for almost all purposes. Steel is now used for boiler plates.

Corrosion and Preservation of Iron.—Iron becomes affected by corrosion sooner when partly wet and partly exposed to the air than when it is wholly immersed in water or wholly exposed to the air. Cast iron and steel cannot resist very long the effects of warm or impure sea water. The best and the most malleable irons are attacked more easily than others, by sea water, when used alone. Cast iron may last for many years without rusting when the skin is not injured, as it is covered with a film of the silicate of the protoxide of iron, produced by the sand of the mold on the metal. Chilled surfaces, being deprived of this coating, rust more rapidly.

The following recommendations for preserving iron are made by good English, French and American authorities: 1. To boil the iron in coal tar; the process is more effective when the pieces have first been heated to the temperature of melting lead. 2. By heating the pieces to the tempera- of melting lead and smearing their surfaces while hot with boiling linseed oil, which dries and forms a varnish; thus

the metal is well prepared to receive the paint. 3. After the iron is heated it is covered with mineral bitumen or Asphaltum in the solid state. Iron so protected had resisted the atmospheric inflcences for 15 years; with all other materials, it had been attacked by rust. (See Painting.)

Frauds.—Every experienced person knows that iron work offers great opportunities of perpetrating frauds, as already stated in Part First of this GUIDE. It is asserted by most reliable parties, some architects, builders, and foundry men also, known to be perfectly honest, that some iron work specified 1½ inches thick and contracted for, has been reduced down to ⅞ or ¾ of an inch in thickness, and no proportioned deduction was made from the amount of the contract. Moreover, in many cases, some men in order to succeed in deceiving others may make only the edges of plain surfaces in iron work of the right thickness, which they reduce abruptly for saving material. The thickness of each part of the work should always be equal on the whole surface, except when otherwise specified. All thicknesses of iron work should always be carefully figured in the specifications, and the same should be thoroughly inspected before the work is accepted, according to the present method of contracting for this branch of the work.

Best Way of Preventing Frauds.—As the iron work is estimated by the pound, so it would be better for architects and owners to contract with foundry men for so many pounds of iron required for a building, and the iron work should be weighed on *tested scales* before being set up. But care should be taken that the strength or thickness of iron is not exaggerated for the purpose of increasing the amount of the contract in order to derive larger profits from it. The strength or thickness required for iron work depends of course principally on the weight it has to support, and all educated architects can solve this problem, and ascertain also, at least approximately, the weight of all iron required, so as to give the owners a fair idea of the cost

of the work, when completed, before he enters into any contract. This method is generally adopted in France and some other countries of Europe, and should also be introduced into this country, as it is the most accurate and reliable, especially for all irregular parts of the work, such as moldings and ornaments, etc., and the most effective in checking all possibilities of perpetrating frauds. This way does not give the architect or owners more trouble, than to inspect and examine carefully the thickness of every part and detail of the work, as it should be done, under the present method.

Weight of Cast Iron, Wrought Iron and Steel.

PER SQUARE FOOT.

From $\frac{1}{16}$ to 1 inch in thickness.

THICKNESS.	CAST IRON.	WROUGHT IRON.	THICKNESS.	CAST IRON	WROUGHT IRON.
Inches.	Decimals of lbs.	Decimals of lbs.	Inches.	Decimals of lbs.	Decimals of lbs.
$.\frac{1}{16}$	2.346	2.517	$.\frac{9}{16}$	21.119	22.659
$.\frac{1}{8}$	4.693	5.035	$.\frac{5}{8}$	23.466	25.176
$.\frac{3}{16}$	7.039	7.552	$.\frac{11}{16}$	25.812	27.694
$.\frac{1}{4}$	9.386	10.07	$.\frac{3}{4}$	28.159	30.211
$.\frac{5}{16}$	11.733	12.588	$.\frac{13}{16}$	30.505	32.729
$.\frac{3}{8}$	14.079	15.106	$.\frac{7}{8}$	32.852	35.247
$.\frac{7}{16}$	16.426	17.623	$.\frac{15}{16}$	35.199	37.764
$.\frac{1}{2}$	18.773	20.141	1.	37.545	40.282

NOTICE. The weight of cast iron in this table is taken at 450 lbs per cubic ft.

The weight of cast iron varies from 450 to 460 lbs per cubic foot.

The weight of wrought iron is taken at 480 lbs per cubic foot.

Steel weighs about 490 lbs per cubic foot; therefore in order to ascertain the weight of steel an addition of about 2 pounds in 100 pounds must be made to the tabular amounts of wrought iron.

The weight of wrought iron varies from 480 to 490 lbs per cubic foot.

COPPER.

Pure copper has a pale red color. Its hardness and elasticity are very great and it can be hammered into fine leaves.

Through the process of *copper smelting* about eleven *specimens* are produced. The first is *calcined ore*, or *copper ore* after the extraction of the sulphur. The last specimen is *tough bar copper,* as prepared for the manufacture of wire.

Sheet copper makes excellent and durable roofs, but being very expensive, it is not much used in this country for that purpose, except in a few cities. It is principally employed for hips and valleys (angles on roofs) and flashings on roofs along walls and dormer windows, for gutters and down-spouts; and also for bath-tubs, boilers, etc. Copper takes a green rust or calx, which rather preserves than destroys the metal; therefore it is most excellent for cramps in stone work, but six or eight times more costly than iron.

If water is to be conveyed from roofs to cisterns or tanks, copper should not be used about them, because the surface of this metal is covered with a *film of verdigris*, which is poisonous. (See Lead.)

Alloy.—Alloyed with zinc, copper forms brass for the handles of doors, shutters, locks, drawers. The usual proportion is 1 part of zinc to 3 parts of copper. Copper with tin, in the proportion of $\frac{1}{10}$ to $\frac{1}{5}$ of the whole forms a composition called *bronze* or *bell metal*, used in the casting of statues, bells, guns, etc. When tin is of $\frac{1}{3}$ of the alloy, a beautiful white, closed grained, brittle metal is formed, susceptible of a very high polish.

Solder.—Solder for copper and brass is composed of an

alloy of zinc and copper; for pewter, an alloy of tin, lead and bismuth.

Sheets of Copper.—The sheets of copper as manufactured are of different sizes. The sheets in general use are of two sizes: 30x60 inches, and 20x72 inches; the first is most employed. The sheets of each size are of various weights according to the strength or thickness of the metal; and they are graded thus: 8 lb. copper; 10 lb. copper; 12 lb. copper; 14 lb. copper; 16 lb. copper; 18 lb. copper, and so on; 12 lb, 14 lb. and 16 lb. copper are in general use Then, when the specifications call for 12 lb, 14 lb. or 16 lb. copper, or any other weight, this means either a sheet of copper 30x60 inches, or the other of 20x72 inches, of one of the weights stated above. In this case as in many others, the specifications are not always explicit enough, for no one but the experienced man knows what 12 lb. or 14 lb. copper means. The specifications should always mention the weight of metal for a sheet of a certain size, or the weight of one square foot; and the last method would be the best.

Frauds are reported to be perpetrated sometimes in using light sheets for heavier ones as specified; 12 lb. copper may be used in placed of 14 or 16 lb. copper, and even 10 lb. copper for heavier metal, and the latter grade is too light to be employed for building purposes, at least outside.

To detect frauds in copper work see the table below, and when the work is going on, compare the weight of metal used with that specified, either by weighing one square foot of the metal, or making the test with the use of a *guage* made expressly for that purpose, which gives accurately the thickness or strength of the metal and its weight per square foot. This *guage* can be had from the wire manufacturers; and every architect, builder, and superintendent of buildings should have it.

TABLE SHOWING THE

Various Weights of Copper Sheets

of each size, and also their weights per square foot, to enable any one to compare the weight or strength of metal used with that specified.

1. Size of sheets, 30x60 inches.

Weight per sheet. *lbs.*	Weight per square foot. *oz.*	*dr.*
10	12	12
12	15	6
14	18	—
16	20	8
18	23	—

2. Size of sheets, 20x72 inches.

Weight per sheet. *lbs.*	Weight per square foot. *oz.*	*dr.*
10	16	—
12	19	3
14	22	6
16	25	9
18	28	12

Sheets of the above sizes are *mercantile*, and are made as heavy as 100 pounds. Sheets of other sizes are made to order.

ZINC.

Zinc contains originally an admixture of lead and sulphur, and when purified from these, it is of a light blue color, between lead and tin. Before being calcined, the ore is first hand-dressed to free it from foreign matter.

A sheet of pure zinc is of an even color without black spots and blotches, bending readily in the hand, and will

not easily break ; if not pure, it is the contrary to all this. Cement does not injure zinc, but lime and calcareous waters destroy it ; and zinc pipes to flues over wood fires are destroyed by them. Zinc is very much used in England and France for roofs ; but in this country it is not much employed outside except for ornamental work. Zinc makes good roofing except for large flat surfaces, unless each sheet is laid free from the other, at least for countries of extreme hot and cold weather. It is used also for lining water-tanks. Zinc which contains iron is worthless, and not much better if it possesses lead.

Galvanized Iron or *Zincked Iron* is that iron which has received a coat of zinc. The metal is first cleaned perfectly by the joint action of dilute acid and friction, and afterwards thrown into a bath of melted zinc, covered with sal-ammoniac, and stirred until the iron is sufficiently covered with zinc. Zinc sheets are of different sizes ; the size generally used is 36x84 inches.

Galvanized Iron is said to be almost as durable as copper or lead ; it costs more than plain iron and increases its strength and durability. It is very much used for cornices, fronts of dormer windows, and even sometimes for fronts of some buildings, facing wooden framing, and for gutters and down-spouts. It costs more than wood-work but less than cast iron in such cases, being used much thinner.

Solder.—Soldering done with block tin and lead melted together in equal parts, is used for zinc, galvanized iron and tin, and also for copper and brass ; when applied to the last two metals it is called soft solder. The more lead is mixed in the solder over one half, the more inferior is the solder. Spirits of salts, killed by putting about three ounces of zinc to a pint spirits, are put on the metal before the soldering is done.

To detect Frauds in Zinc or *Galvanized Iron Work*, follow the same rule as for copper work.

TABLE SHOWING THE

Different Numbers and Weight of Zinc Sheets

And also their weight per square foot

Sheets, 36x84 inches.

Number.	Weight of sheets. lbs. *(Decimals.)*	Weight per square ft. lbs. *(Decimals.)*
6	10.05	0.47
7	11.47	0.54
8	12.90	0.61
9	14.32	0.68
10	17.16	0.82
11	20.00	0.95
12	22.84	1.09
13	25.68	1.22
14	28.52	1.36
15	31.36	1.49
16	34.20	1.63
18	45.55	2.17
19	51.23	2.44

TABLE SHOWING THE

Different Numbers of Wire-Guage

And weight of galvanized sheet iron per square foot.

Wire-Guage. No.	Weight per square foot. Oz.	Wire-Guage. No.	Weight per square foot. Oz.
30	10	22	21
29	11	21	24
28	12	20	28
27	14	19	33
26	15	18	37
25	16	17	43
24	17	16	48
23	19	14	60

Numbers usually employed :— No. 26 is light; No. 24 is medium; No. 22 is heavy; No. 20 is extra heavy. The

dimensions of sheets generally used are from 24 to 30 inches wide by 8 feet long.

Juniata Galvanized sheet-iron is the best, and should always be used for good work in buildings.

Another kind of iron, called *Charcoal Galvanized Iron,* is good enough and principally used for gutters and down-spouts and stove-pipes. Bad iron will crack and sometimes break when bent.

Galvanized iron cornices are laid on wooden brackets, or on angle wrought iron ones $1\frac{1}{4}$ inch wide on each side and from $\frac{3}{16}$ to $\frac{1}{4}$ of an inch in thickness, placed at every four feet.

TIN.

Tinned Sheets, when properly laid, make a very good covering for roofs, and if painted occasionally, will last for a considerable length of time. The best way to lay it down is to double-lap the edges of the sheets, and insert white lead between them as they are fixed; by this means they are rendered perfectly secure against the admission of wet without the use of solder. Tinned iron nails are generally used; copper nails are the best, but more expensive.

Three different kinds of tin are used:

Charcoal Tin Plate or *Bright Tin* is the very best *roofing tin.*

Roofing Tin or *Terne Plate* is very good.

Coke Tin Plate is an inferior quality, and should not be used for building purposes.

Tin is sold in boxes, some containing 225 sheets, and others 112.

TABLE SHOWING THE

Marks of the Different Grades of Tin

And the size of sheets in each quality.

CHARCOAL TIN PLATE, OR BRIGHT TIN. *		ROOFING TIN, OR TERNE PLATE.		COKE TIN PLATE.	
Grade.	Size of sheets.	Grade.	Size of sheets.	Grade.	Size of sheets.
IC	10×14	IC	14×20	IC	10×20
IC	12×12	IX	14×20	IC	14×20
IC	14×20	IC	20×28	IC	10×14
IX	10×14	IX	20×28		
IX	12×12				
IX	14×20				
IXX	14×20				
IXXX	14×20				
IXXXX	14×20				
IX	20×28				

* Sheets 14x20 IX and 20x28 IX are principally used.

Sheet of tin 20×28 inches square, IC, weighs 2 pounds, or about ½ pound per square foot.

Sheet of tin 20×28 inches square, IX, weighs 2 pounds 6½ ounces, or about 9½ ounces per square foot.

Gutters and down-spouts are made of either tin (heavy), copper, or galvanized iron of Nos. 24 and 26.

Gutters are 15 inches girt for cheap houses; 20 inches girt for first-class houses; from 20 to 30 inches for large buildings.

The down-spouts are from 3 to 5 inches diameter for ordinary buildings, and 6 inches diameter for large ones.

Sheets of copper 20×72 inches are generally used for spouts.

LEAD AND PLUMBING WORK.

Lead is of a bluish white when first broken, less elastic and sonorous than any of the other metals, and the heaviest of all except gold and quicksilver. It is easily calcined, and soluble in all acids and alkaline solutions. Lead will form a union with most other metals except iron. It is the most fusible, next to tin. It is run from the furnace into molds; the main foım being called *Sow*, the smaller ones, *pigs*; and from these into sheets, pipes, etc., etc.

There are two sorts of sheet lead: *cast* and *milled*.

Sheet lead is used in Europe for covering large buildings; but in this country, for outside work, it is principally employed to cover hips and valleys (angles on roofs) and ridges (apex of roofs), and for flashings along walls and dormer windows, etc. Lead is also used to fasten iron cramps, posts and bars into masonry by filling up the cavities between them. Thin sheets of lead are sometimes placed under the shaft and between the drums of columns and in the bed joints of wrought stone arches, to distribute between the stones.

Tanks over bath-rooms and water-closets in country houses are lined either with that metal or zinc; and lead or other metals should be also used for gutters, instead of copper, in all houses where tanks or cisterns are supplied from the roof, because water from copper gutters is poisonous.

IMPORTANT NOTICE TO OWNERS, TENANTS, AGENTS, ARCHITECTS, BUILDERS, PLUMBERS, ETC.

Great Frauds in Plumbing Work.—It is generally acknowledged by experienced men and even by some plumbers that no trade of the building business offers more opportunities of perpetrating frauds, than Plumbing, as the largest and most expensive portion of it is usually covered immediately after the work has been done. Therefore, the closest attention should be given at the right time to this branch of the work which involves comparatively large sums of money.

I will expose and explain in detail all the frauds known to be so frequently perpetrated; give all the most reliable informations on this subject, and suggest all practical ways and means, enabling anyone to prevent or detect all such frauds which may be again attempted or perpetrated in future.

Lead Pipes.—The lead pipes, as it is generally known, vary in size and strength. The size of a pipe is taken inside; for instance, when we say a "$\frac{5}{8}$ inch pipe," or a "$\frac{3}{4}$ inch pipe," this means that the bore or inside diameter is $\frac{5}{8}$ or $\frac{3}{4}$ of an inch, and so on. The size of pipes varies from $\frac{1}{4}$ of an inch to 5 inches. Nearly all pipes of each size are also of different strength and weight, which of course are regulated by the thickness of the metal; and the pipes are graded thus (in all places west of the Allegany mountains): Aqueduct, Extra Light, Light, Medium, Strong, Extra Strong.

Consequently, two pipes of the same length and same bore or inside diameter may differ very much in weight.

The tables below give the various grades of pipes, and their weight per lineal foot for each grade, as they are sold to plumbers by manufacturers.

Attachment or Supply Pipes.—Water is introduced into ordinary houses with $\frac{5}{8}$ of an inch Extra Strong pipes; in large houses, with pipes $\frac{3}{4}$ of an inch Extra Strong; and pipes from $\frac{3}{4}$ of an inch to $1\frac{1}{2}$ inches Extra Strong, or more, are used for the same purpose in some public buildings, such as hotels, office buildings, etc.

The portion of the pipe running from the City Main to the stop-cock outside, is laid under the supervision of the city authorities, who of course always see that a pipe of the required strength is used; but, from the point of the stop-cock, frauds are sometimes perpetrated by using a lighter pipe than Extra Strong, as specified and contracted for. None but Extra Strong pipes should be used to introduce the water into buildings, for resisting both the pressure of the water and the effects of frost.

If Extra Strong pipes were always employed in place of weaker ones, they would not burst out so often, especially in winter time; which defect results in repeated and very costly repairs.

Waste-pipes are not less than $1\frac{1}{4}$ inches Light for wash-stands, china closets, and from $1\frac{1}{2}$ to 2 inches Light for bath-tubs and kitchen-sinks. Some larger ones are sometimes used. Light pipes are sufficiently strong for these purposes, as they have not much pressure to resist; but Extra Light pipes, which are too weak, are sometimes used instead of Light pipes, as specified and contracted for.

Frauds are also perpetrated sometimes in changing one size pipe for another, as well as the strength of the pipe, as stated above.

Soil Pipes.—Cast iron soil pipes are generally used instead of lead pipes for water closets; they are from 4 to 15 inches in diameter, 4 inches being the usual size for all dwellings. All these iron pipes of one diameter are of the same strength or thickness of metal; consequently no fraud can be perpetrated in this case, except by substit-

uting a pipe of a smaller diameter in place of another specified.

Notice.—The specifications should always state the weight of lead pipes per lineal foot, besides, or instead of, using the terms of "Light, Strong, or Extra Strong," which no one can understand but the experienced persons. Then after the owners have been secured with the specifications at the right time, when the work is going on, and before the pipes are covered, if they have any doubt about the strength of pipes used, they can become satisfied by cutting a piece exactly one foot long, weighing it, and comparing its weight with the specifications and principally with the tables below. This cutting would not at all damage the pipes, which can be soldered easily at a very small price, and be quite as strong as before. This is the only way, for inexperienced persons at least, to detect frauds in lead pipes.

Bath-tubs are made of cast-iron, zinc and copper; but copper tubs are in general use. All good copper tubs are stamped at the head near the top. The strength of the metal ranges from 8 to 22 ounces per square foot. It is rumored that tubs of 8 ounces per square foot are some. times used instead of others 10, 12 or 14 ounces per square foot, as specified. Those inferior tubs are not stamped, as every one can see.

Then it is necessary that the specifications, in stating the weight of metal per square foot, should also call for bath-tubs *stamped* (if good tubs are required). But the stamp, which is supposed to indicate the exact weight of metal, has been in some cases counterfeited; therefore, the proper way of making the test is to use a *guage* made expressly for that purpose, which gives accurately the thickness or strength of the metal and its weight per square foot. Water-closets are of various sorts, as further described.

Frauds in Sheet Lead.—The lining under bath-tubs, water-closets and wash-stands is done in sheet-lead, which should not be less than 3 pounds per square foot. Sometimes lead weighing 2 or 2½ pounds per square foot is used instead of lead weighing 4 or 5 pounds as called for by the specifications. This fraud in sheet lead, as in sheet copper, can be detected (as stated for copper work) either by weighing 1 square foot of the metal, or by using the *guage* (which gives accurately the thickness of metal and its weight per square foot) and comparing its weight with that mentioned in the specifications.

Hopper Closets are principally used in basements and in some rude buildings.

Boilers are made of wrought iron, copper, and galvanized iron; but rounded-head galvanized iron boilers are in general use now. They are of different capacity, and the metal is about of the same strength in all of them; they can resist 130 pounds pressure to the square inch, and bear a stamp which indicates the capacity in gallons. Boilers rest on iron stands.

Frauds are sometimes perpetrated in substituting a boiler of less capacity than that specified and contracted for; 30 gallon boilers may be furnished in place of 40 gallon ones, and so on. This fraud can easily be detected by any one, (even if the stamp does not indicate the capacity of the boiler) in measuring the length and diameter, which give the capacity in gallons, as shown further by a table.

Marble tops are made ⅞, 1, 1¼ and 1½ inches thick; plain, molded, and counter-sunk. American marble is often used instead of Italian marble as specified; the latter costs much more. The best way to remove the opportunity of perpetrating this fraud is to call for the best American marble in the specifications, as it is good enough for all purposes.

Cocks are of different styles and qualities, and are made of brass, plain, and silver or nickel plated. Fuller's pat-

ent cocks are the best in use; cocks of some other manufactures are also good; but some very inferior ones are sometimes used in place of the best compression cocks, as called for by the specifications.

Stoneware Sewer-pipes are from 3 to 30 inches bore (inside diameter) in length of 2 feet to the socket. Their junctions should always be carefully cemented with the best cement mortar. (See "Brick and Bricklaying, etc.")

Precaution.—No plumbers should excavate under masonry walls, to make their sewer-pipe connections. (See "Precaution Against Accidents in Stone Masonry.")

The Greatest Frauds.—It is asserted that second-hand, old and damaged goods are sometimes substituted in place of new articles, as specified and contracted for. Old damaged water-closets, broken porcelain basins and urinals, broken or cracked iron sinks, may be furnished in some buildings after having undergone some little repairs. The greatest care and attention should be given against these abuses.

Some old broken sewer pipes are sometimes used. They are not always well repaired, nor are their junctions well cemented. Then the ground, which becomes saturated from the leakage of the sewers, may spread through the building a most disagreeable and unhealthy odor, against which a remedy is often sought in vain at a large expense.

Great Schemes of Plunder may be sometimes perpetrated by calling in the specifications a larger number of water-closets, bath-tubs, sinks, basins and wash-stands, than that intended to be used in a building, in order to lead some mechanics astray in their estimates and secure also the opportunity of deriving larger gains from the work.

Defects in Materials and Workmanship.—A large amount of work is done in a most defective manner, resulting either from carelessness, wrong intentions, too low prices, insufficient knowledge of the trade, and from mechanical inability. Very bad material is sometimes used;

the soldering of pipes and other connections in many places are not properly made. Care should be taken that no plumbers injure the carpenter's work and weaken the timbers of floors, etc., by cutting holes for pipes.

TABLES SHOWING THE

Sizes and Weights of Lead Pipes

Produced by two large Manufactories.

Note.—It will be seen that they differ in the weights of some pipes of the same grade and size.

ST. LOUIS LEAD PIPE AND SHEET LEAD WORKS.

Bore or inside diameter.		Weig't per ft lbs.	Weig't per ft oz.	Average length.
1/4 in.	light		8	270 feet
	strong		12	180 "
	ex. strong	1	4	108 "
3/8 in	light		12	180 "
	medium	1		135 "
	strong	1	8	90 "
	ex. strong	2		67 "
1/2 in.	light	1		135 "
	medium	1	4	108 "
	strong	1	12	100 "
	ex, strong	2	7	71 "
5/8 in.	ex. light	1	4	108 "
	light	1	12	100 "
	medium	2	4	78 "
	strong	2	8	70 "
	ex. strong	3		58 "
3/4 in.	ex. light	1	8	116 "
	light	2		87 "
	medium	2	8	70 "
	strong	3		58 "
	ex. strong	3	10	48 "
1 in.	ex. light	2	4	78 "
	light	2	12	64 "
	medium	3	8	50 "
	strong	4		44 "
	ex. strong	4	12	37 "
1 1/4 in.	ex. light	2	12	64 "
	light	3	4	54 "
	medium	4		44 "
	strong	4	8	39 "
	ex. strong	6		29 "
1 1/2 in.	ex. light	3	8	50 "
	light	4	4	41 "
1 1/2 in.	medium	5	4	33 feet
	strong	6	4	28 "
	ex. strong	7	2	25 "
1 3/4 in.	ex. light	3	12	46 "
	light	4	8	39 "
	medium	5	8	32 "
	strong	6	8	27 "
	ex. strong	8	4	21 "
2 in.	ex light	4	8	39 "
	light	5	8	32 "
	medium	7		25 "
	strong	8		22 "
	ex. strong	9	8	18 "
2 1/2 in.	3-16 thick	7	13	15 "
	1/4 thick	8	13	15 "
	5-16 thick	13	11	15 "
	3/8 thick	16	12	15 "
3 in.	waste	5		15 "
	3-16 thick	9	5	15 "
	1/4 thick	12	10	15 "
	5-16 thick	16		15 "
	3/8 thick	19	11	15 "
3 1/2 in.	1/4 thick	15		15 "
	5-16 thick	18	5	15 "
	3/8 thick	21	12	15 "
	7-16 thick	26	11	15 "
4 in.	waste	5	5	15 "
	1/4 thick	16	12	15 "
	5-16 thick	21		15 "
	3/8 thick	25	4	15 "
	7-16 thick	30		15 "
4 1/2 in.	waste	5	12	15 "
5 in.	waste	8		15 "

FOUNTAIN OR AQUEDUCT PIPE.

	lbs.	oz.	Length
1/4 inch		6	360 feet
3/8 "		8	270 "
1/2 "		10	216 "
5/8 "		12	180 "
3/4 inch	1	2	120 feet
1 "	1	12	77 "
1 1/4 "	2	4	60 "

L. M. Rumsey & Co.

Bore or Inside Diameter.	Weight per foot lbs.	oz.
¼ inch tubing		6
⅜ inch acqueduct		8
light		12
medium	1	
strong	1	8
ex. strong	2	
½ inch acqueduct		10
ex. light		12
light	1	
medium	1	4
strong	1	12
ex. strong	2	8
⅝ inch acqueduct		12
ex. light	1	4
light	1	12
medium	2	
strong	2	8
ex. strong	3	
¾ inch acqueduct	1	
ex. light	1	8
light	2	
medium	2	4
strong	3	
ex. strong	3	8
⅞ inch acqueduct	1	8
ex. light	2	
light	2	8
1 inch acqueduct	1	8
ex. light	2	
light	2	8
medium	3	4
strong	4	
ex. strong	4	12
1¼ inch aqueduct	2	
ex. light	2	8
light	3	
medium	3	12
strong	4	12
ex. strong	6	

Bore or Inside Diameter.	Weight per foot. lbs.	oz.
1½ inch adqueduct	3	
ex. light	3	8
light	4	
medium	5	
strong	6	
ex. strong	7	8
1¾ inch ex. light	3	12
light	4	8
medium	5	8
strong	6	8
ex. strong	8	
2 inch waste	3	
2 inch ex. light	4	
light	5	
medium	7	
strong	8	
extra strong	9	
2½ inch 3-16 thick	8	
¼ thick	11	
5-16 thick	14	
⅜	17	
3 inch waste	5	
3-16 thick	9	
¼ thick	12	
5-16 thick	16	
⅜ thick	20	
3½ inch ¼ thick	15	
5-16 thick	18	
⅜ thick	21	
4 inch waste	5	
¼ thick	16	
5-16 thick	21	
⅜ thick	25	
7-16 thick	30	
4½ inch waste	6	
5 inch waste	8	

Sheet Lead.—The various weights of sheet lead per square foot are: 2, $2\frac{1}{2}$, 3, $3\frac{1}{2}$, 4, $4\frac{1}{2}$, 5, 6, 7, 8, 9, 10 lbs., and upward.

Sheet $\frac{1}{64}$ of an inch thick weighs 1 lb. per square foot.

The connections of water-closets are made with the best glazier's putty.

Solder.—Lead pipes are connected with solder made of 2 parts of lead and 1 part of best block tin.

Water-closets most generally used are:

Jennings' London closets, of two kinds: all earthenware and iron-trap closets. Both are considered the best in use; they are the most expensive, and waste much water.

Carr's water-closets, of two kinds: OIC and Defiance, which is of the best American manufacture and good enough for all classes of buildings.

IXL water closet, manufactured in St. Louis, is a very good closet.

There are some other cheap closets, such as: Carr's improved water-closet, and Smith's valve water-closet.

No water-closets have reached perfection yet, consequently great improvements in that line are expected from inventors.

Wash-stands.—Cabinet wash-stands in black walnut, or veneered; marble-top, size of slab 33×20 inches, used for one bowl; height of back, 10 inches.

Corner cabinet wash-stand; size of slab, 22×22 inches; height of back, 10 inches.

There are some fancy iron wash-stands on standard, from 27½ to 31 inches high to front of slab, and from 32 to 39 inches to top of back. The bowl is 12 inches diameter.

Sectional slabs and bowls with patent overflows, rubber plugs and brass couplings, for hotels, barber-shops, plain, painted and enameled.

Washstands on iron frames.—The usual size is: height, 31½ inches, back 24½, width 19½ inches, bowl 12 inches; plain, painted and enameled.

Bath-tubs.—Copper bath-tubs, metal weighs 8, 10, 12, 14, 16, 18, 20 and 22 ounces per square foot.

New York pattern tubs are 4½, 5, 5½, or 6 feet long; the French tubs are 4½ feet long.

The cast iron bath-tubs with patent overflow and rubber plugs, French pattern, are from 4½ to 5 feet long, 23½ inches wide and 19 inches deep.

Boilers.—Those in general use are of the capacity of 30, 40, 60, 80 and 100 gallons.

The capacity of wrought iron boilers is from 18 to 192 gallons. Other sizes are made to order. The boiler stands are made of iron; the size of ring is 12, 13, 14, 15, 16, 17, 18, and 20 inches diameter.

Capacity and Sizes of Boilers.

CAPACITY.	SIZE.
18 Gallons	3 feet by 12 inches
21 "	3½ " 12 "
24 "	4 " 12 "
27 "	4½ " 12 "
30 "	5 " 12 "
36 "	6 " 12 "
35 "	5 " 13 "
24 "	3 " 14 "
28 "	3½ " 14 "
32 "	4 " 14 "
36 "	4½ " 14 "
40 "	5 " 14 "
48 "	6 " 14 "
42 "	4 " 16 "
52 "	5 " 16 "
63 "	6 " 16 "
53 "	4 " 18 "
66 "	5 " 18 "
79 "	6 " 18 "
82 "	5 " 20 "
98 "	6 " 20 "
100 "	5 " 22 "
120 "	6 " 22 "
120 "	5 " 24 "
144 "	6 " 24 "
168 "	7 " 24 "
192 "	8 " 24 "

Porcelain Basins, patent overflow, for rubber plug; outside measure in inches, 12, 13, 14, 15 and 16 inches diameter.

Slab and basin combined, square 18×18 inches, and 11 inch basin.

Copper Sinks. Size in inches: 12×18, 14×16, 14×20, 14×24, 16×24, 16×30, 18×30.

Iron Sinks.—The size of iron sinks varies from 13×19 to 24×50 inches; they are 4½, 5, 6 and 6½ inches deep, and have corners round inside and square at top.

Extension Sinks with round corners inside, square at top, and extension to put pump on; size, 18×32, 20×38, 22×44, 23×50.

Corner Sinks. Size in inches, 20×29, 22×31; 6 inches deep.

Half-Circle Sinks. Size, 24×14; 27×15; 31×17; 6 inches deep.

Slop-Sinks. 16×16, 10 inches deep; 14×20; 20×24; 20×30; 12 inches deep.

Hydrant Cess-pools. 14×14; 16×16; 6 inches deep.

Sewer-Traps. 16×16, 10 inches deep; 20×20, 12 inches deep.

Grate-Top Sewer-Traps. 16×16, 10 inches deep.

Cess-Pool Plates. 6×8.

Corner Urinals. 9, 10, 11, 12 inches on side.

Side Urinals. 12 and 15 inches back.

Porcelain Urinals. Flat Bedfordshire Urinals, of two sizes: 12½×16½; 15½×18½ inches.

Corner Bedfordshire Urinals. Two sizes: 10×14, and 12½×16½.

Couplings are made of either cast iron or brass.

Brass plugs and couplings are generally used for basins, bath-tubs and boilers.

Rubber stoppers are sometimes employed.

Pumps, hose-pipes, showers, are of various styles.

Gas-fitting.—Gas pipes are usually made of wrought iron. They are not less than $\frac{3}{8}$ of an inch bore (inside diameter) for one or two burners. Supply-pipes for eight or nine rooms are at least $\frac{3}{4}$ of an inch. They vary from $\frac{3}{8}$ of an inch to 3 inches diameter, depending on the class of buildings.

Weight of Copper, Lead, Brass and Zinc per square foot, $\frac{1}{4}$ inch in thickness, in decimals of lbs., is as follows: Copper, 11.560; Lead, 14.765; Brass, 10.6; Zinc, 9.35.

SLATE ROOFS.

The pitch for slate roofs, except the Mansard and Gothic roofs, is generally $\frac{1}{4}$ of the span or width of a double-pitched roof, and sometimes only $\frac{1}{5}$. Roofing slates are usually $\frac{1}{8}$, $\frac{3}{16}$ and $\frac{1}{4}$ inch thick, and of different lengths and widths. They are nailed either to the purlins or cross-bearers, 3x1$\frac{1}{2}$ inches, laid in for that purpose, or to a sheeting of narrow boards or battens, grooved and tongued $\frac{7}{8}$ or 1$\frac{1}{8}$ inches thick, which should always be used instead of rough boards, for all good houses as well as for public buildings. Each slate is to be laid on with two nails 5 inches down below the upper end and about 1 inch from the side edges. The nails used are either of copper, zinc, or of either galvanized or tinned iron. The last two kinds and also merely plain iron ones are in general use. The iron nails are boiled in linseed oil, to be partially preserved from rust. This precaution, however, does not always have the desired effect, for the nails will rust and break,

and the slates will fall out. The copper nails are more expensive than all others, but the most durable; therefore it is safer and will be more economical to use them, as they may last as long as the slates.

On iron roofs the slates are tied by wire, either to iron purlins or iron laths. In three courses of slates, the lower end of the top course should lap 3 inches over the upper end of the lower course, and so should it go on, except for mansard roofs and spires, where a 2-inch lap is sufficient. The part exposed to the weather is proportioned to the length of the slates used.

Slating is started at the eaves; the lowest course of slates rests at the lower end on a strip of wood about $\frac{3}{8}$ or $\frac{1}{2}$ inch in thickness, nailed to the sheeting, and a little bevelled to suit the slope of the slates.

In order to prevent rain or snow from penetrating inside through the joints, a coat of cement mortar about $\frac{1}{4}$ of an inch thick is sometimes put on the touching surfaces of the slates; but this is not very good and causes trouble and much difficulty in replacing sometimes broken slates by new ones. When the board or batten sheeting is used, the best way is to cover it (as it is often done) with thick brown paper soaked in tar, instead of cement. The slates are laid on top.

Different Kinds of Slates.—

"Evergreen Slate Company" in Vermont manufactures green slates of an unfading and very good quality.

Vermont possesses quarries of green, red and purple slates of good quality.

New York State has quarries of excellent green and purple slates.

Pennsylvania possesses valuable quarries of a dark blue colored slate.

"Peach-Bottom Quarries," on the Susquehanna river, in Maryland, furnish also a superior quality of dark-blue colored slate.

Nature of Slate.—Slate is a species of argillaceous stone, and is an abundant and most useful mineral. Its constituent parts are: argil, earth, silex, magnesia and lime, for the best; slate containing iron should not be used, as it will rust and soon decay.

Qualities of Slates.—If a slate, when struck, produces a sonorous, clear, bell-like sound, it is of an excellent quality. The feel and the aspect of a slate are other indications of its quality; if it is good it has a hard and rough feel and a clear appearance; if it is weak, soft and absorbent it feels smooth and greasy, and has a dull earthy aspect.

Slates which absorb the least water are the best to resist atmospheric influences. If the slates absorb and retain much moisture the boarding will soon become rotten.

The best method of testing the quality of slates is by the use of water, in two ways:

The first is to lay the pieces edgewise in a tub of water, the water reaching a little above half-way up the height of the pieces; if they absorb water and become wet at the top in eight hours' time, they are weak and bad; and as water reaches less the top of them, so are the pieces better.

Another way of making the test is to weigh the pieces of slates and note their weight. Let them stand about 12 hours in water, then take them out and wipe them dry. Those that are much heavier when re-weighed than before their immersion, should be rejected.

Flashings along walls, dormer windows, etc., hips, ridges and valleys are made of either zinc, lead or copper. Zinc is not very good; lead is better, and copper is the best.

Lead weighing 2½ lbs. per square foot is used for flashings; lead of from 2½ to 4 lbs. per square foot, for hips and ridges; copper, 19 oz. per square foot, for valleys.

The Frauds reported to be perpetrated in slating roofs, by deviating from the specifications and the contract, are the following:

Thin slates may be used instead of thick ones; slates of very inferior quality for the best; cheap iron nails, that are not good, for copper or galvanized iron nails; the metal used may be much weaker than that specified.

To Detect Frauds follow the directions mentioned above to test the quality of the slates. See that they are of the thickness contracted for, for this makes a great difference in the cost of the work. (See the various thicknesses stated above.) As regards the metal, the specifications should always mention the weight per square foot; then, when the work is going on, make the test, either by weighing one square foot of the metal used, or by using the guage (as above stated for copper and lead work), and comparing its weight with that specified.

(Refer to the Tables of Sheet Metals.)

Enamelled Slate is worked for chimney-pieces (mantels) to represent marbles. It is also used for covers to stoves and hot-water coils, and other decorative purposes. The process, which requires a great care, is simply *painting* at a great heat.

Weight of Slate.—Per cubic foot, 174 lbs; per square foot, 1 inch thick, 14 lbs; $\frac{1}{4}$ inch thick, 3 lbs. 8 oz.; $\frac{3}{16}$ inch thick, 2 lbs. 10 oz.; $\frac{1}{8}$ inch thick, 1 lb. 12 oz.

Stopping Joints on Roofs.—A mixture of white lead paint ground in oil, and mixed with sand enough to prevent it from running, is excellent; it should be protected by strips of lead, tin or copper, etc., bent and introduced into the mortar-joints, which should be scraped out deep enough, and refilled afterwards. Mortar, which is sometimes used for that purpose, is not as good as paint and sand. Cement-mortar, with blacksmith's cinders and molasses used for this purpose is good and becomes very hard.

GRAVEL COMPOSITION ROOFING.

The best felt paper made out of woolen rags, and saturated with coal-tar preparation, is laid in three or four ply. The last should always be used for good work. A coat of composition (pitch) is put on, and while hot, the gravel is applied. The best quality of this kind of roofing may last fifteen years on the average.

Asphalt Roofing—The best asphalt roofing is of a great durability. Natural asphalt has been known to remain exposed for ages without alteration, being unchangeable in the atmosphere, and not liable to suffer injury by the greatest alternations of frost and thaw. The asphaltic cement is very strong and tenacious, and is not liable to crack in cold or run down in hot weather. It emits no disagreeable odor and does not affect the water. The same kind of felt paper as for the ordinary gravel composition roofing is used; it is saturated with asphalt. When laid down a coat of asphaltic cement is put on, and while hot, gravel is applied.

In some places metal flashings are used along the walls, in connection with composition roofing.

Frauds.—Straw felt is sometimes used in place of the best kind (woolen felt), as specified and contracted for. It is much cheaper, and when saturated, the difference can only be found out by an expert. Roofing laid on with straw paper is not durable and results almost in a waste of money. Particular attention should be given to this kind of Roofing.

SHINGLE ROOFS.

The best shingles are made of white cedar; and those of the best quality may last from 40 to 50 years in the northern countries; others are made of white pine, cypress and poplar, and being cheaper than cedar shingles, they are much more used, though not half as durable. Shingles are 16 inches long, and from 6 to 10 inches wide. Shingling must be begun at the eaves and extended upwards. Shingles are laid so that not quite ⅓ of their length is exposed to the weather. Two nails are used to each one. Wrought iron nails are the best; cut nails are apt to break by the warping of the shingles. In countries of a damp, warm climate, all shingles decay in less than 12 years.

PAINTS, Etc.

White lead, which is the principal basis of all stone colors, is carbonate of lead, generally containing hydrated oxide of lead, which is sometimes combined in the proportion of one part of hydrated oxide to two of carbonate of lead. It is usually made either by precipitation, as when carbonic acid or a carbonate is to decompose a soluble salt or a subsalt of lead; or by exposing plates of cast lead to the joint action of the vapor of acetic acid air, and carbonic acid. It is by the latter process that the resulting carbonate of lead is obtained of that degree of

ture, which fits it for paint. Fine lead is also made from *Slag lead*, which is treated with nitrate of soda.

Oxide of Zinc is known for its intense whiteness, its resistance to sulphurous and other deteriorating causes, and its harmless qualities to the painter and the inmates of the house under decoration. It is requisite that the oil used should be as white as possible. Proper drying oils will cause zinc white to dry as quickly as the other color.

Fancy Colors.—All colors that are called *fancy colors* have *white* for their bases; chocolate, black, brown and wainscot only excepted. The fancy colors are: drabs, French grays, peach blossom, lilac, light green, patent greens, blues, vermilion, lake, etc.

Oxides of Iron.—The paints prepared from the oxides of iron are pronounced by some men of experience to be quite as good as those prepared from the oxides of lead, and their cost is considerably less.

Reds have mostly their bases in iron.

Blacks.—Lamp-black is only the smoke from various substances; and the best is from coal tar.

Ivory black, or *bone-black* is only charred bone. It is not as good for paint nor does it work as freely as lamp-black. Asphaltum is a most intense black when several coats are laid on, but of very little service when exposed to the weather. It produces the black varnish used for japanning tin and other metals.

Copper is the base of most blues and all the mineral greens.

Linseed oil.—The best linseed oil is obtained from good Baltic and Bombay linseed, crushed.

Mineral Turpentine is sometimes used as an adulteration of that article; the paint mixed with it dries and then softens, becoming sticky even under a coat of sugar of lead and varnish. Wood work prepared with bad linseed oil for being stained, prevents the varnish from drying; [illegible] quired.

Turpentine is made of the gum of a tree (pine) from North Carolina, etc.

Nut oil has been stated to be more durable and to resist the effects of the weather much longer than any other oil in paint; but being too expensive it is not much used.

Pumice stone is a lava of the volcanoes, found floating upon the surface of the sea. It is a very useful article for rubbing down painted work.

Varnishes.—The best varnishes are made of gum copal; they are of various qualities.

Wearing body varnish, used principally for outside work, dries from 12 to 16 hours. It produces a fine lustre and is the most durable.

Furniture Varnish, or varnish termed "Inside Coach Varnish," drying in from 7 to 10 hours is used for inside work.

PAINTING.

The best materials used for house painting are generally known to be white lead and oxide of zinc. Both are ground in linseed oil and sold in kegs of different sizes.

Preparation of Paints.—To prepare the paints for immediate use, an addition of 3½ pints of oil to 10 lbs. of the keg paint, will be required to make it flow easily under the brush.

Four coats of best quality paints are sufficient for any class of work.

Preliminary work.—Before the painting is commenced, all surfaces intended to be painted should first be freed from dust and thoroughly dry. All the wood work should

be perfectly smoothed off by sand-paper for the neatest finish; all nail heads to be punched to about $\frac{1}{8}$ of an inch deep. Should any part of the surface be greasy, the grease should be removed with lime water.

Killing Knots.—The knots on white and yellow pine are to be perfectly *killed*, as the painters term it.

A good way of doing this is to dry and burn out the turpentine which the knots contain, by using a considerable quantity of lime immediately after it is slacked. Another usual mode of producing the desired effect, is by coating the knots with pure gum shellac varnish mixed in alcohol. If the knots still appear after the priming coat is put on, they should be covered with silver or gold leaf. For superior work a hot iron is held over the knot till a good part of the pitch has come out and been scraped off, when the two coats of the leaf will keep out both the pitch and any discoloration.

Priming.—When the *killing* of the knots is completed, the first coat (called *priming*) is put on, which generally consists of white lead and a little red mixed in linseed oil The paint for priming should be as thick as will spread easily, and then will be rubbed out under the brush. All work both externally and internally may be primed in the same manner.

Puttying.—After priming is done, all the nail-heads, cracks, etc., in the work should be well filled with glazier's putty. If the putty is put on before priming, it will be apt to fall out, because the wood would absorb the oil from it, and then the putty would shrink.

Glazier's Putty.—The best glazier's putty is made of linseed oil, and fine, clean, washed chalk (whiting) mixed with a small quantity of litharge to insure the hardening; flour, baryta and lead are sometimes added to the putty. If the work is intended to be white finish, the second coat should be half oil and half turpentine; if it is to be four-

coat work, the third coat should be about $\frac{1}{3}$ oil and $\frac{2}{3}$ turpentine; and the fourth coat all turpentine.

Turpentine diminishes the tendency of the paint to become yellow, and is much cheaper than oil; but it should not be used for any outside work, for it is more susceptible of water than oil, and of course not so well adapted to preserve the work exposed to the weather.

Oil produces a glossy, and turpentine, a flat surface; a glossy finish can be secured when no more turpentine is used in the thinning.

Plastered surfaces should be perfectly dry before being painted in oil, otherwise the paint may blister; but they can be painted in water-colors immediately after the plastering is done.

Dryers.—When raw oil is used for thinning the paint, dryers should also be employed to hasten the hardening of each coat. The dryers commonly used are: powdered litharge, sugar of lead, sulphate of zinc in the proportion of one heaped teaspoonful or one tablespoonful of Japan varnish to 10 lbs. of keg paint. Turpentine is not considered as a dryer; but evaporating in a short time, it always hastens the hardening of the paint, and it is more fluid than oil. Litharge or Japan is a good dryer for outside work, and for priming inside; also for dark colors. Sulphate of zinc is only fit for the last coats on the inside; sugar of lead is sometimes used. Either of them can be dissolved in water and stirred into the color.

Colors.—When some other colors are desired instead of a white finish, the coloring ingredient is mixed with the white paint for the last coat, and sometimes for two coats, to produce the most satisfactory effect. The various colors used are: blues, lamp-black, terra sienna, umber, ochre, chrome yellow, venitian red, red lead, etc., ground in oil, and well mixed with the white paint.

Each coat dry.—In all cases every coat should be perfectly dry before the subsequent one is put on. Color

requires more drying in winter than in summer. Outside work will last longer when painted in cold weather, because the liquid does not evaporate so much, and the surface retains a heavier body of the paint.

Transparent colors will work more freely, and spread on with an evener flow, by being mixed with raw oil and japan, with a little water stirred in.

Thick Colors.—When thick colors are mixed, the liquid should be added gradually, otherwise the lumps will not be thoroughly broken.

Drying oil (colorless).—Boil linseed oil for two hours with three per cent. of red lead, filter it, and then expose it to sunlight in large shallow vessels, frequently renewing the air above.

Polish White and Glossy Finish.—Oxide of zinc, being whiter than white lead, is the paint required to do this kind of work properly. It is produced by mixing the paint with Damar varnish, or white copal varnish. The common method is to finish with the polish white after priming and the second coat has been put on in the usual way with lead.

Best Method.—Put on two coats, as above, and then spread on several coats of yellow ochre, turpentine and japan, with a little litharge. When dry, rub smooth and level with pumice stone, then a coat polish white, and finish with a flowing coat of white varnish, in which is mixed some zinc white. When work is to be finished with a gloss, the previous coat should be a dead surface, and if it is to be flattened, the previous coat should have a degree of gloss.

Paints to Preserve Iron.—The best paints to preserve iron work exposed to the weather, and also metal roofs, are pulverized oxides of iron, such as yellow and red iron ochres, and brown hematite iron ores, finely ground, mixed with linseed oil and a dryer.

Spanish Brown is an excellent color for tin roofs, spouts, gutters, etc. Iron work should have at least three coats of paint, and roofs two coats.

Sanding.—The process of sanding the outside work is performed by throwing fine white sand twice, on the last coats of paint before they are dry.

Imitations.—Pine work is now very frequently painted in imitation of some kind of hard wood, such as Black Walnut, Oak, Mahogany, Rosewood, Maple, Satin-wood, etc. It is very seldom that any good house is finished without the introduction of some graining. The best imitations are made by copying from nature; and in order to secure any degree of perfection in the imitations of any woods or marbles, it is necessary to procure a specimen of the material itself as a model, and copy the color and form of the grains as near as possible.

There are two methods of graining woods. Graining in oil and graining in distemper.

Graining in Oil.—The grain color is to be mixed in boiled oil and turpentine.

Graining in Distemper is a method of painting wherein some liquid other than oil or water is used for thinning the colors. Ale, beer, whisky, or vinegar are generally used. Stale ale or beer is the best, though whisky may be preferable in cold weather, because it does not creep like other fluids, and it is sufficient to rub the ground work with it. The grain colors are Brown and Burnt Sienna, according to the tints required.

For distemper graining, the ground work is to be dampened by rubbing all over with a sponge wrung out of the liquor, before putting on the grain color. For the ground of graining, as in other mixtures, the body color is taken first, and the positive colors are added by degrees, till the required tint is produced. The work may be primed with any light color, as for other work. The second coat must approach to the ground color, and the graining is performed on the third coat, which should be mixed with a gloss, either for inside or outside work.

Good work requires three coats of ground. The sponge,

cloth, brush or any tools used must be often washed out while doing the work.

Glazing colors are transparent, and mixed very thin.

Graining is most generally done after the wood has been painted. In the best work the coats are thicker than usual to afford a good ground for the combing. Grained work, when varnished, is more lasting than plain painting. When the work is to be grained, each coat, after priming, should be composed of about one-half of oil and one-half of turpentine. Before laying on the second coat, the work should be rubbed down with fine sand paper and stopped with best oil putty where necessary. The second coat also should have a little rubbing and sometimes stopping. In order to save delay and check all annoyances which may be caused by painting, a preparatory sizing is required, which prevents the smell of paint from being scarcely perceived; this produces a very brilliant effect.

The best system of graining Oak and Black Walnut, is the oil color process.

For all hard, close grained woods, such as Mahogany, Rosewood, Satinwood, and Maple, graining in distemper is much preferred by some painters, to oil graining. Black Walnut also is sometimes grained in distemper.

WOOD FILLER.

Wheeler's Wood Filler has been tested by many of the largest manufacturers of all kinds of Furniture and Cabinet ware. All who have tried it, without an exception, have adopted it, and freely acknowledge its great superiority over all other modes of finishing wood.

Its advantages are:

1. It fills the pores of wood perfectly, so that a smooth finish is obtained with one coat of varnish.

2. It is a non-absorbent, and is not affected by water or damp atmosphere.

3. When once in the pores, it cannot be wiped out. In all fillers heretofore used, the particles were round. In this filler, the particles are angular and sharp, and readily adhere to and unite with the pores and fibres of the wood.

4. It is perfectly transparent under the shellac or varnish, therefore does not spoil the beauty or life of the wood.

It is put up ready for use, for both dark and light wood, in packages of 2, 5, 10, 20, 25, 40, 50, 100, 200, 300 and 500 lbs.

Varnishing.—Before varnishing is commenced, all work should be prepared with a dead surface, either by rubbing down with pumice stone, or by mixing with turpentine. Work intended to be very finely finished, with a level surface, is rubbed down with solid pumice stone and water; when smoothness only is required, it is rubbed with pulverized pumice stone and water, using for a rubber any woolen cloth, felt, or buckskin.

The first coats of water are spread on evenly, and well rubbed; a few coats may be given without rubbing, and before the last is put on, the work should be rubbed till

the gloss is entirely destroyed; afterwards a heavy flowing coat of varnish is given. When work is to be finished in a cheaper way, the rubbing with pumice stone is not done. Two or three coats of water well rubbed out are sufficient, and on the last coat while being sticky, a heavy flowing coat of thick varnish is put on. This may be polished, when thoroughly dry.

Polishing.—The work is rubbed down with finely pulverized pumice stone, until it becomes smooth and even, and after it has been washed, it is rubbed with rotten stone and sweet oil. After the oil has been cleaned off, the work is polished with chamois leather. The under coats of paint should be thoroughly dry, otherwise the varnish would be apt to crack.

Old Work.—When old work is to be repainted, it should be well rubbed down with pumice stone and water, and then carefully dusted off when dry; the cracks and openings must be well stopped with oil putty. After this, a mixture of white and a little red lead with equal parts of oil and turpentine, is used to paint the work, which is generally termed "second" coloring old work. After this coat has become dry, a mixture of old white lead, with a small portion of blue-black in a medium of half-bleached oil and half turpentine, is used for finishing, or, if flatting be intended, the former preparation will be suitable for receiving lead white or any fancy color. The same process will serve for stuccoed walls, observing that, if more coats be required, the mixture of half oil and half turpentine is proper.

Frauds.—The frauds known to be perpetrated in painting by deviating from the specifications and the contract, are the following:

White lead is often largely adulterated with sulphate of baryta, whiting, etc., which may be detected by insolubility in dilute nitric acid, whereas pure white lead is entirely dissolved by it.

Vermilion, which is composed of sulphur and quicksilver, may not always be used when called for; then some imitation of that beautiful color takes its place. The greater portion of the Chinese vermilion, being adulterated with pulverized glass, is almost worthless; hence, it appears that frauds have reached the Celestial Empire also. The best comes from France; the American and English vermilions are cheaper; they are not bad, but inferior in color.

Common oil and varnish may be often used; a large quantity of soap may be employed in graining.

Two coats of paint may be put on instead of three coats, and three instead of four. A coat may be laid on before the previous one has become sufficiently dry.

Defects in Priming.—In many cases there is not enough attention paid to priming (first coat); the color being mixed up *too thin* and put on *too heavy*; the reverse is known to be much better.

Puttying, which is too often done with the fingers, cannot fill the holes well. In no case should this practice be tolerated. Puttying should always be done with a putty-knife.

Remark.—There are different grades of white lead: 1. Strictly pure white lead. 2. Pure white lead, which is white lead mixed with zinc white; and some inferior grades.

Painting stands much longer in cold than in warm countries. In the latter, the best paint may not last over five years, outside, as the sun will soon burn out the oil. In the interior of buildings, the imitation can stand from twenty to twenty-five years; but plain painting, which has to be washed so often with hard rubbing to be kept clean, wears out much sooner. Bad paints may not last two years; they soon crack and peel off.

TEST OF THE PURITY OF WHITE LEAD.—IMPORTANT TO OWNERS, TENANTS, ARCHITECTS, BUILDERS, PAINTERS, ETC.

The following is an infallible and simple commercial test of the purity of White Lead:

Take a piece of firm, close grained charcoal, and near one end of it scoop out a cavity about half an inch in diameter and a quarter of an inch in depth. Place in the cavity a sample of the lead to be tested, about the size of a small pea, and apply to it continuously the *blue* or *hottest* part of the flame of the blow-pipe; if the sample be strictly pure it will, in a very short time, say in two minutes, be reduced to metallic lead, leaving no residue; but if it be adulterated, even to the extent of ten per cent. only, with oxide of zinc, sulphate of baryta, whiting or any other carbonate of lime, (which substances are now the only adulterations used,) or if it be composed entirely of these materials, as is sometimes the case with cheap lead, it cannot be reduced, but will remain on the charcoal an infusible mass.

Dry White Lead, (carbonate of lead,) is composed of metallic lead, oxygen and carbonic acid, and when ground with linseed oil forms the White Lead of commerce. When it is subjected to the above treatment the oil is first burned off, and then at a certain degree of heat the oxygen and carbonic acid are set free, leaving only the metallic lead from which it was manufactured. If, however, there be present in the sample any of the above mentioned adulterations, *they* cannot of course be reduced to metallic lead, and cannot be reduced by any heat of the blow-pipe flame to their own metallic bases; and being intimately incorporated and ground with the carbonate of lead, they prevent *it* from being reduced.

It is well after blowing upon the sample, say half a minute, by which time the oil will be burned off, to loosen the sample from the charcoal with a knife blade or spatula, in order that the flame may pass under as well as over and against it. With proper care the lead will run into one button, instead of scattering over the charcoal, and this is the reason why the cavity above mentioned is necessary. A common star candle or a lard oil lamp furnishes the best flame for use of the blow-pipe; a coal oil lamp should not be used.

By the above test, after a little practice, so small an adulteration as one or two per cent. can be detected; it is however only a test of the *purity* or *impurity* of a lead, and if found adulterated the degree or percentage of adulteration cannot be well ascertained by it.

Jewellers usually have all the necessary apparatus for making the test, and any one of them can readily make it by observing the above directions, and from them can be obtained a blow-pipe at small cost.

If you have no open package of the lead to be tested, a sample can most easily be obtained by boring into the side or top of a keg with a gimlet, and with it taking out the required quantity; care should be used to free it entirely from the borings or particles of wood, and it should not be larger than the size mentioned;—a larger quantity can be reduced, but of course more time will be required, and the experiment cannot be so neatly performed.

Although the above description is necessarily somewhat lengthy, this test is really very simple, and any one can very soon learn to make it with ease and skill.

GLASS.

Glass is a combination of silex with fixed alkali, generally soda. Its fineness depends on the purity and proportion of the ingredients. A superior crystal glass contains 16 parts of quartz, 8 parts of pure potash, 6 of calcined borax 3 of flake white, and 1 of nitre. The glass generally used in this country is from American, English, and French manufacturers, and is of various classes, viz: Single strength; Double strength, and Plate glass.

Single Strength Glass is graded thus: AA, or best quality; A, or second quality; B, or third quality; C, or fourth quality; all these qualities are used; it is from $\frac{1}{16}$ to $\frac{3}{32}$ of an inch thick.

Double Strength Glass is graded as follows: AA, or best quality; A, or second quality; B, or third quality; first and second quality are generally used; it is $\frac{1}{8}$ of an inch thick.

Single and double strength glass is made of all sizes to 40 inches wide by 70 inches long.

Polished Plate Glass is always the best quality, from 40 inches wide by 70 inches long, to 8 feet wide by 14 feet long, and $\frac{3}{16}$, $\frac{1}{4}$, and sometimes $\frac{3}{8}$ of an inch thick.

Skylight Glass, made in England, is very much used in this country; it is from $\frac{1}{8}$ to $\frac{13}{64}$ of an inch thick.

Rough Plate Glass, which is also manufactured in this country, is employed for roofing, skylights, etc., in plates from not above 20 inches long, to above 120 inches long, in thicknesses of $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$ inch, $1\frac{1}{4}$ and $1\frac{1}{2}$ inches; but the latter thicknesses have certain limited lengths. This glass is not ground or polished.

There is another rough glass, manufactured in France and England, which is much used for ridge and furrow roofs, skylights, workshops, and other places where

obscured glass is required to intercept the vision without diminishing the light. It is made of two kinds: 1. Plain, and 2, fluted of two sorts: No. 1, large pattern, having large flutes; No. 2, small pattern, having small flutes. Both the plain and the fluted kinds are made $\frac{1}{8}$, $\frac{3}{16}$, $\frac{1}{4}$, $\frac{3}{8}$ and $\frac{1}{2}$ inch in thickness. The width is about 3 feet and the length is not usually above 70 inches; but 75, 90, and 100 inches long are also made. No. 2. fluted, is a clear and non-transparent glass.

Weight.—

1 square	foot	of	glass	$\frac{1}{16}$	inch	thick	weighs	12 oz.
"	"	"	"	$\frac{1}{8}$	"	"	"	1 lb. 8 oz.
"	"	"	"	$\frac{1}{4}$	"	"	"	3 lbs.
"	"	"	"	1	"	"	"	12 lbs.

The frauds reported to be perpetrated by deviating from the specifications and the contract, are as follows:

Glass of inferior quality and single strength may be used instead of the best and double strength glass. This latter fraud can be easily detected by comparing the thicknesses of the glass used, with those stated above. The best quality of glass is perfectly free from all defects.

American glass may be sometimes used instead of the English or French, which is more costly. The best way to check this fraudulent speculation, would be always to call in the specifications for glass of American manufacture, which is good enough for building purposes, when the kind wanted can be procured in this country.

Let everybody know that Crystal City, Missouri, manufactures Plate glass equally as good as any of European manufacture. Other American manufacturers produce the very best kind of single and double strength glass.

The French glass is of a light green and a little clearer than the American and the English, which are of a dark green. The former is superior to the latter, for picture frames. The French glass is the most costly, and the American is the cheapest.

GLAZING.

Glazing consists in fitting glass in sashes and frames, either in putty or lead. It is classed thus: Sash work; Lead work, and Fretwork.

Sash Work.—Sashes or frames receive one coat of paint before being glazed. Each glass is to be secured into position with four tins or more (according to the length of glass) on the two long sides.

Putty and Puttying.—The putty used should be the same as described under the head of Painting. Soft putty is the best. The hard putties are apt to crack, if not soon well painted.

In good work, when medium-sized glass is used, after the glazing is done and the putty well set, the spaces on the inside should be filled.

Bedding for superior work is the best, when large glass is used; the rabbet to be glazed with soft putty, and the glass pressed down into it as close as possible, and then to be glazed as usual.

Cleaning.—After the glazing is done, it is cleaned either with water and a brush, or with whiting and a dry brush.

Glass is removed from old sashes by a mixture of 1 part of unslacked lime with 3 parts of American potash, laid on both sides and kept there for about 24 hours; then the putty has become soft enough to be cut out and easily removed. Paint and tar also can be taken off by the same mixture.

Lead Work for fixed lights is used principally in ecclesiastical buildings. The lights are fastened to saddle bars in frames made with cross-bars.

Fretwork is the ornamental part of lead-light work, and consists in working stained or ground glass into different patterns and devices. Each glazing panel is surrounded

with a lead about $\frac{3}{4}$ of an inch broad in the leaf, to make the work stronger.

Saddle bars are usually placed from 6 to 9 inches apart.

Gilding is done in oil-size on wood work, and in water-size on plastering. When metal is to be gilded, it must receive a coat of paint or some other substance to prevent *oxidation.* The gold leaf of various thicknesses is called "single," "double," "thirds," and of "tints." It is furnished in books containing generally 25 leaves; each leaf covering about 1 foot of plain work.

Paper-hanging.—Papers are printed from 8 to 12 yards in length, and 1 foot 8 inches wide; such a length is called a *piece.*

Precaution.—Arsenical Green in printed papers is considered very injurious to health, from its flaking off in light particles, and floating in the air, when it is taken into the lungs while breathing. This color may be at once detected by placing a few drops of *Ammonia* on it, whereby the green will be changed into a deep blue.

Satin papers are usually hung over a lining paper.

Walls of rooms should always be stripped before the new paper be laid on. In bad or common plaster's work, the setting coat often comes off in parts with the paper and has to be repaired. A coat of *clearcole* is usually applied for preparing the walls to receive the paper.

STEAM HEATING AND VENTILATING.

Steam heating is effected either through direct or indirect radiation. For direct radiation three lineal feet of pipe 1 inch diameter (inside) will heat 75 cubic feet without fail, and for indirect radiation, three lineal feet of pipe (same size) can heat only from 40 to 50 cubic feet; (depending of course on the situation and exposure of the rooms.

The foul air flues should be about 1 inch square for every 30 cubic feet, in a hall where a great many people congregate, and 1 inch square for every 40 or 50 cubic feet in a dwelling house.

The best method of introducing fresh air in rooms is from below, through ducts of the same area as for foul-air flues. These ducts should be opened near the floor, and placed on the same side with the heaters and opposite to the foul-air flues, which should also be opened as near to the floor as possible. The fresh air is usually heated by a coil placed at the point where the vertical portion of the duct commences.

Vertical tube radiators of wrought iron are used for direct radiation, with covers, made of either slate, marble, or iron.

Horizontal stacks or coils, either of cast or wrought iron are employed for indirect radiation, and usually placed in the basement.

Hot-air flues are made of IX Bright Tin, 1 inch square per 60 cubic feet.

The registers and ventilators are usually made of cast iron, from 4×8 to 27×38 inches square; others are made to order.

Wrought Iron Pipes.

PLAIN, ENAMELLED, AND GALVANIZED, FOR STEAM, GAS, AND WATER.

INSIDE DIAMETER	WEIGHT PER FOOT.	INSIDE DIAMETER.	WEIGHT PER FOOT.
$\frac{1}{8}$	.24	$4\frac{1}{2}$	12.49
$\frac{1}{4}$	.42	5	14.56
$\frac{3}{8}$	.56	6	18.77
$\frac{1}{2}$	.85	7	23.41
$\frac{3}{4}$	1.12	8	28.35
1	1.67	9	34.07
$1\frac{1}{4}$	2.25	10	40.64
$1\frac{1}{2}$	2.69	11	....
2	3.66	12	....
$2\frac{1}{2}$	5.77	13	....
3	7.54	14	....
$3\frac{1}{2}$	9.05	15	....
4	10.72		

MANTELS, GRATES, AND HEARTHS.

Mantels are made of marble, slate enamelled, cast iron enamelled from $\frac{1}{8}$ to $\frac{1}{4}$ of an inch thick, limestone, and wood.

The grates are at least of twenty different patterns.

Hearths are made of slate and marble from 1 to $1\frac{1}{2}$ inch thich, and stone from $1\frac{1}{2}$ to 3 inches thick. They are usually 16, 18, and 20 inches wide by 4 feet 8 inches, 5 feet and 5 feet 6 inches long. Marble hearths are principally used.

Vestibule floors are laid with platforms and steps $1\frac{1}{2}$ inches thick, and risers 1 inch plain and $1\frac{1}{2}$ inches molded.

Marble tops are $\frac{7}{8}$, 1, $1\frac{1}{4}$, and $1\frac{1}{2}$ inches plain, molded and counter-sunk. The various kinds of marble in general use are: Mexican Onyx, Missouri Onyx; German, various grades and colors, and various prices. Lisbon, two grades, yellowish red color, various prices.

Tennessee. Dark red, three grades, and Knoxville, red with black veins, three grades; various prices for both kinds. Dark red is about double the price of Knoxville.

Italian Statuary (white marble,) and others of bluish color, two grades, No. 1 with light veins, No. 2 darker. The light is a little more costly.

Vermont Statuary (white), various colors, grades, and various prices.

All kinds are used for mantels. No. 3 Vermont, white, with dark veins, is generally used for hearths; Italian No. 1 for vestibules.

Frauds.—Marble of inferior quality is sometimes used in place of a superior grade, as contracted for. When American marble is used instead of the Italian, it is generally of the worst kind, so as to resemble the color of the latter.

Remark.—The best American marble is good enough for all purposes, and should always be called for.

In laying tiles when the Portland or other best cement is required, and called for by the specifications, very common cement which costs only one-quarter of the former, is sometimes used.

ELECTRIC BELLS, SPEAKING TUBES AND BURGLAR ALARMS.

Heisler's system has superseded in regard to quality, finish and durability, not only the old pull bell and tube system, but has been successfully introduced into dwellings where other electric and pull bell systems have been found useless. His system is generally specified by all the leading architects for all classes of buildings, viz:

Bronze Front door lever pull, with bell in kitchen and hall. Side door pull to ring in kitchen.

One servant's bell to ring from front chamber.

Stable bell to ring from front chamber and dining room.

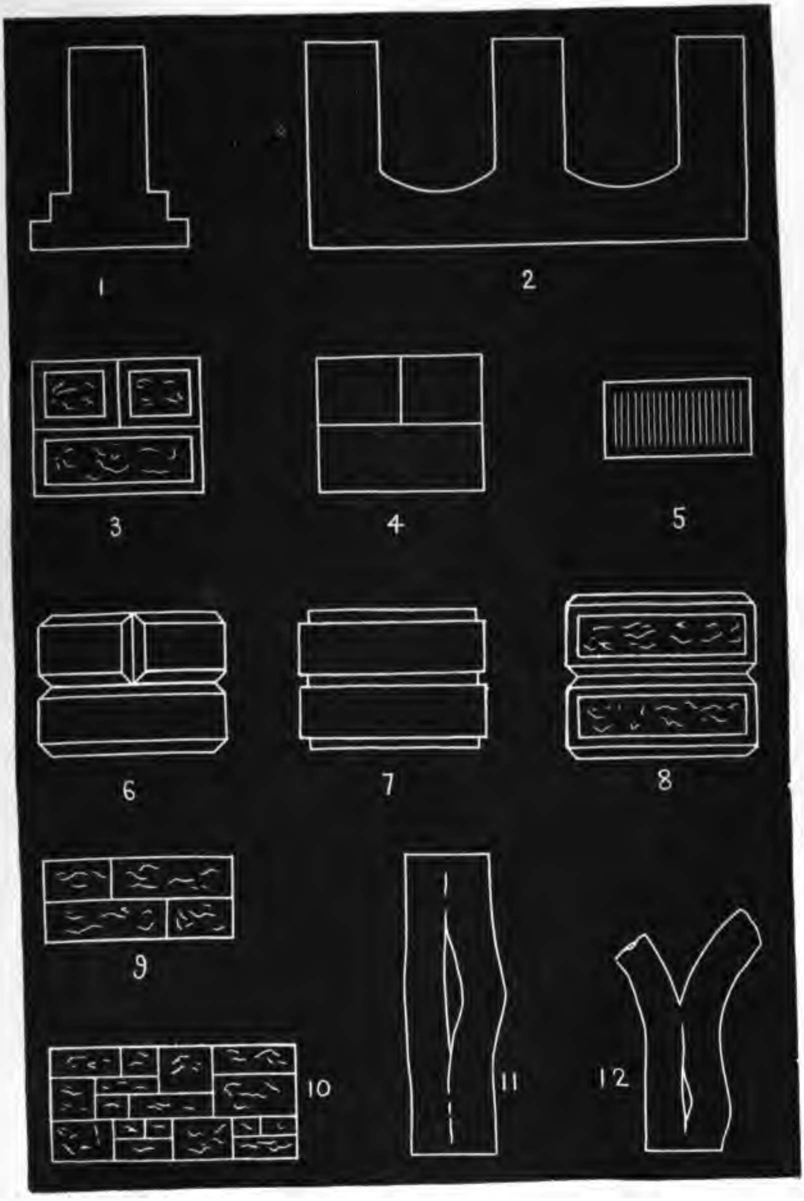
Dining room floor contact, to ring in the kitchen.

Heisler's continuous speaking-tube system in connection with parlor, library, sitting-room, four chambers in second story, and four chambers in third story.

All to terminate in the kitchen.

One 5 number "Burglar Alarm Annunciator" to be connected with all the windows on the first floor and basement, doors of first and basement floors.

Omission.—As regards tin work; IC tin (light weight) is sometimes used instead of IX tin (heavy), and painted on one side only, instead of both sides, as specified and contracted for. (See the weight of tin per sheets and square foot.)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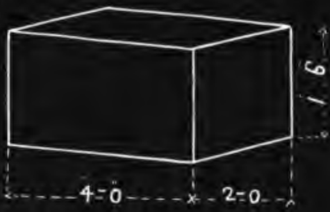

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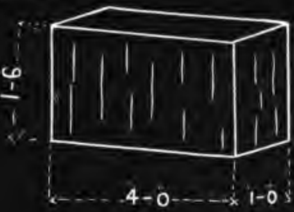

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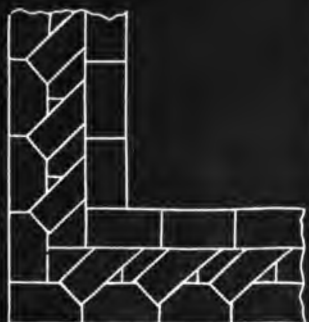

NOTES.

The State of Maine possesses quarries of superior quality slate. Virginia also has quarries of excellent slates.

Cements from Akron, Ohio; Akron, New York; and cement from Akron, Ills. which has already been mentioned, are excellent.

Gypsum, known as Plaster of Paris, which is a sulphate of lime, is also found in abundance through this country.

Remark about Glass.—The weights of glass per square foot, stated in this work to be 12 oz. for $\frac{1}{16}$ of an inch thick; 1 lb. 8 oz. for $\frac{1}{8}$ of an inch thick; 3 lbs for $\frac{1}{4}$ of an inch thick, and 12 lbs for 1 inch thick, are rather light, but correct for glass which is not of the exact thicknesses stated above (when supposed to be such). The weights of glass are usually taken at 13 oz. for $\frac{1}{16}$ of an inch thick; 26 oz. for $\frac{1}{8}$ of an inch thick; 52 oz. for $\frac{1}{4}$ of an inch thick; 13 lbs for 1 inch thick. Sheets of glass are often very irregular in thickness, and of course vary in weights.

Cement Paving.—Good paving is made of English Portland cement, laid in blocks of from 3 to 4 inches in thickness. When the ground is exposed to running water, as is the case of inside walks, a concrete foundation 6 inches thick at least should be laid first to receive the paving. When this kind of work, which requires the best quality of cement and concrete, is done with inferior materials, it is considered worthless. Particular attention should be paid to cement paving, in which great frauds may be perpetrated.

NOTICES.

The Galvanized Iron Skylights, Galvanized Iron Cornices, Window Caps and other Sheet Metal Trimmings, manufactured by A. C. Dunlevy, and also by Cochran & Kammerer, give the best satisfaction, being used by leading architects on some of the most important buildings.

Rules of Measuring Adopted in St. Louis.

Notice.—These are principally the general rules, and of course details are not thoroughly considered.

Excavation is measured by the cubic yard, that is, 3 feet by 3 feet = 9 feet by 3 feet = 27 cubic feet. The length multiplied by the depth, and this amount multiplied by the average depth, will give the cubic contents in feet; the product divided by 27 feet will give the amount of cubic yards.

Rubble Masonry is measured in St. Louis, according to custom, by the perch of 22 cubic feet as follows: Say one wall 20 feet long by 10 feet deep = 200 feet, by 2 feet thick = 400 cubic feet, divided by 22 feet = 18 perches and 4 feet. Openings of ordinary size are not deducted. Circular or oval work is usually measured double. All outside corners are measured double; thus, in a foundation of a building 40 feet square, each side is measured 40 feet long. Division or party walls are measured as they are (net measure inside.) Some allowances are usually made for projections and isolated piers, over their real contents.

Range-work is measured by the superficial foot, all openings being deducted. Piers built of dimension rock are measured by the cubic foot.

Stone-cutting.—The cubic contents of all parts of the work are usually first taken, and afterwards the surface of the same, where worked, are measured by the superficial foot. For molded work on cornices, architraves, etc., the girt of all the moldings is measured. One dimension multiplied by the other gives the number of superficial feet. Allowances are made for circular and paneled work. All parts of the work 1 foot wide, or under, are measured by the lineal foot. All openings are deducted.

Pointing to fronts is measured by the superficial foot.

Brick-work is measured at per thousand bricks laid in the walls. A superficial foot of brick-work 4 inches or ½ brick thick, is supposed to contain 7 bricks; 8½ inches or a whole brick, 14 bricks; 12¾ inches or 1½ brick, 21 bricks; 17½ inches or 2 bricks thick, 28 bricks, and so on; every additional brick of course adding 7 bricks to the cubic contents per square foot of the surface. All outside corners are measured double, as for stone masonry; the party or division walls are measured as they are (net measure). The openings are deducted from the top of the sill to the springing of the arch (the point where the arch commences). When the brick-layer sets the window or door frames, the width of the opening should be deducted only inside of the frame. Bond timber, chimney flues and fire-places are not deducted. All projections are measured, and a fair allowance must be made for cutting bricks.

Paving is measured by the superficial yard; 40 bricks laid flatwise, and 75 bricks laid edgewise, are allowed for one yard.

The St. Louis Hydraulic Press or Stock Brick, is of different grades or qualities, viz:

No. 1. Light red, defective, with spots, cracks, and edges chipped and corners broken, especially after having been laid.

No. 2. Little darker, fair quality.

No. 3. Perfect brick, of a medium color, which is generally used for nice fronts.

No. 4. Perfect brick, dark red, is the strongest.

No. 5. Darker than No. 4, not quite so good.

No. 6. Very hard and strong, but warped and crocket.

Weight.—Hard, 5 lbs; Medium, 4½ lbs; Salmon, 4 lbs.

Plastering.—Plain plastering is measured by the superficial yard; that is, 3 feet multiplied by 3 feet = 9 feet. One half of each opening, such as doors, windows, etc., is deducted. The whole amount of superficial feet, after the

deductions have been made, divided by 9 feet gives the number of superficial yards. All cornices are measured by the square foot, allowing 1 foot to each mitre, multiplied by the girt. Cornices or moldings under 1 foot are measured by the lineal foot. Ornaments are measured separately; circular work is measured double.

Carpenter's Work.—All timbers, such as girders, joists, studs for partitions, etc., are charged at so much per 1,000 superficial feet of board measure, 1 inch thick, and the labor for laying them is generally valued in measuring the whole surface of framing by the square, that is, 10 feet by 10 feet = 100 feet. Furring of walls, flooring, roof-sheeting and board partitions, are measured by the square, and $\frac{1}{5}$ of the surface is usually added for waste; the same allowance is also made for timbers.

Roofing is measured by the square of 100 feet; that is, 10 feet by 10 feet = 100 feet superficial. No deductions are made generally, but allowances are sometimes made at the eaves and the top.

Painting is measured wherever the brush goes, by the superficial yard, that is, 3 feet by 3 feet = 9 feet. On all framed and molded work, straight measure is taken one way, and the dimensions girted over the moldings, panels, etc., the other way. In windows the space occupied by glass is not generally deducted.

Sewer-pipes are measured per lineal foot.